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SOUND AND VISION BROADCASTING IN GREAT BRITAIN

THE sound broadcasting service of Great Britain has been developed during the past twenty-five years or more with the objective of providing as large a proportion of the population as possible with a regular and efficient service. Up to the present time, this broadcasting has been conducted within the long and medium wave-length bands, and the regional scheme of twin transmitters in various parts of the country was introduced to supply two distinct services which have now become identified as the 'Home Service' and the 'Light Programme'. More recently, a 'Third Programme' has been added within the medium wave-length band. In March 1950 the wave-lengths of many of the broadcasting stations in European countries were adjusted to conform to a new plan which was drawn up at an international conference held in Copenhagen in 1948. This plan allocated to the United Kingdom the exclusive use of one long wave and two medium waves, with an additional eleven medium waves shared with other countries. The re-arrangement of wave-lengths in accordance with the Copenhagen agreement represents an improvement on the Lucerne plan of 1933, and has made it possible to extend the area which the 'Third' programme can cover from its former figure of 55 to about 70 per cent of the population of Great Britain, as compared with 92 and 98 per cent respectively for the 'Home' and 'Light' programmes. But, as is pointed out in the Beveridge Report on broadcasting*, the dominant factor in all European broadcasting is the insufficient supply of long and medium wave-lengths in relation to the demands made for them. This arises from the character of Europe as a collection of independent States in a restricted area, and for the most part densely populated and using different languages. The physical conditions of broadcasting in the United Kingdom are quite different from those of countries such as Australia and New Zealand, and of the two major divisions of North America.

Below the medium wave-band in the radio spectrum, there is the wave-length range from 10 to 100 metres, commonly referred to as the 'short-wave band'. While some portions of this band are used for broadcasting on a continent- or world-wide basis, and in tropical regions, other portions of the band are extensively used for long-distance radio communications of all types. The allocation of all short wave-lengths is still the subject of discussion on an international basis, and moreover they do not provide a means of improving the national broadcasting conditions referred to above.

It is with all the above considerations in mind that the Beveridge Committee has recommended that the B.B.C. should give increased and urgent attention to the development of a scheme for the exploitation of what is termed 'higher-frequency broadcasting'

* Report of the Broadcasting Committee, 1949. (Cmd. 8116.) Pp. vii+327. (London: H.M. Stationery Office, 1951.) 6s. 6d. net.

using frequencies greater than 30 Mc./s., corresponding to wave-lengths less than 10 metres. The Committee points out that by using such shorter waves and the technique of frequency modulation, the United States has been enabled to find full and free expression of their broadcasting requirements through stations which are more than twice as numerous as the fifteen hundred daily newspapers published there.

With full knowledge of the practice and trend of development in America, however, the British Broadcasting Corporation has not been idle in this field. The Corporation's engineers have, for some time past, been conducting at its station at Wrotham experiments to ascertain the effective range of transmission of waves at a frequency of about 90 Mc./s., and to compare the advantages and disadvantages of the two chief alternative methods of modulation, known as amplitude and frequency modulation (A.M. and F.M.) respectively. The Committee was given to understand that the B.B.C. would soon be ready to formulate a practical scheme of development of this technique of higher-frequency sound broadcasting, designed first and foremost to provide a more satisfactory service of reception in large areas of Great Britain which are at present badly served by the medium- and long-wave programmes. The Committee points out, however, that in its view an equally important objective in the development of broadcasting on higher frequencies is that of making possible a greater diversity and independence of programmes. In brief, the future development on these frequencies should make it possible not merely to give the existing B.B.C. programmes to people who now fail to get them, but also to establish local stations in Great Britain with independent programmes of their own.

The development of sound broadcasting on very high frequencies is not without some technical problems. As is mentioned in the Post Office memorandum appended to the Beveridge Report, the use of such frequencies is being explored and developed not only for broadcasting, but also for other radio services including air navigation, radio links in the public telephone service, and for the use of the police and the fighting services. It is a characteristic of very short waves that, under normal conditions, the effective area covered by each station is limited to something not much greater than the optical range. This means that high aerial systems are needed at the transmitting stations to secure as great a range as possible. Conversely, the limitation of range means that a number of stations at suitable geographical separation can use the same frequencies without causing mutual interference.

In order to appreciate fully the possibilities of broadcasting on very high frequencies, it is recommended that the existing plan of the B.B.C. should be revised so as to provide for the immediate installation of a sufficient number of stations in suitable localities, and for the development of many local stations if experiment proves their value. In making these proposals for expediting the development of higher-frequency broadcasting in Great Britain, the Beveridge Committee appeared to be very conscious of the many highly technical problems involved; and it was presumed that the B.B.C. would consult, as seems desirable, such bodies as the Scientific Advisory Committee and the Television Advisory Committee. The continuance of the latter with wider terms of reference to cover high-frequency broadcasting as well as television is recommended in the report. Furthermore, since such developments as are envisaged will involve replacing or modifying the receiving sets of those listeners who are to profit by them, it is important that the manufacturers of radio equipment should be kept informed as completely as possible of the trend of progress with the object of ensuring that the cost of future receiving sets is as low as possible.

The Beveridge Committee received much evidence dealing with television; and its report contains a discussion of some of this material, with the principal objects of discovering the similarities and differences between television broadcasting and sound broadcasting, and of establishing the policy to be adopted for television viewing at home and for showing in public places such as cinemas. On the former point, it is recommended that while it would be wrong to develop television as an off-shoot of broadcasting, both the sound and television broadcasting services should be controlled by the same authority. A conclusion on the second point involves arriving at a proposal which is mutually acceptable to the B.B.C. and the cinema interests; and the report suggests that, provided suitable wave-lengths can be made available for the public showing of television, the Postmaster General should be prepared to license their use by responsible organizations established for this purpose on approved financial terms and on condition that the resulting pictures are made available to the B.B.C.

The report contains details of the B.B.C.'s five-year plan for a nation-wide service of television which was approved by the Government and announced by the Postmaster General in November 1949. The scheme involves the division of the radio-frequency band of 41–68 Mc./s. (wave-lengths 7·3–4·4 m.) into five channels for the use of five high-power transmitting stations in England, Wales and Scotland. To supplement these, five medium-power stations sharing the same channels will be erected in various parts of England, Scotland and Northern Ireland. The high- and medium-power stations in each channel will be separated geographically by an adequate distance to avoid mutual interference, which will be further reduced by the use of vertical and horizontal polarization for the high- and medium-power transmissions respectively. If the progress aimed at is maintained, the whole plan should be in full operation by the end of 1954; and this will bring 78–88 per cent of the population of Great Britain physically within reach of television viewing on one or other of the two distinct standards of reception envisaged. While this leaves considerable areas of the country unprovided for, it is known from experience already available that viewing will still be possible outside the limits of first- and second-class reception. Indeed, as the report states, there are

some 30,000 television sets licensed beyond this range from the two transmitting stations already in operation in London and Birmingham.

In connexion with school broadcasting, the Beveridge Report encourages the B.B.C. to explore the possibility of supplementing the sound programme with television for instructional purposes.

Reverting to the sound broadcasting service, and the desire to make this available to practically every home in Great Britain, it is relevant to conclude by a reference to the relay exchange system, to which some consideration was given by the Beveridge Committee. Under this system, known also as wire broadcasting, programmes picked up at a central point or exchange are distributed over a special wire network to listeners subscribing to the system. The programmes may be picked up at the exchange either by radio or by direct wire from the B.B.C.; and the distribution may be effected either by the use of a suitable carrier wave on which is impressed the sound modulation; or the latter, as an audio-frequency signal, may be transmitted direct to the listener, who then merely requires a suitable loud-speaker for reception. One of the chief advantages of this system is that the listener is not subject to local interference or the corresponding difficulties of reception in a bad area. The main receiving station can be suitably located and provided with a very efficient aerial system, so as to ensure that a good-quality signal is supplied to the wire network. But while these advantages can be achieved in populous districts, the Beveridge Report makes it clear that the relay system is not considered to be the obvious solution to the problem of improving reception conditions in sparsely populated areas generally. On this point, however, it is recommended that the B.B.C., on its technical side, should be asked to report whether there are in fact, any isolated areas or areas of bad reception which can be covered better by relays than by radio. The results of such an investigation may affect a future decision as to whether relay services, at present operated by private enterprise, should be taken over by the Postmaster General as part of the attempt to raise to a reasonable standard the listening conditions in every part of Great Britain. The present conditions of the licence given to relay service operators impose limitations on the time devoted to the distribution of programmes received from abroad; but the Committee points out that a listener with an ordinary receiving set is not tied to the B.B.C. programmes at all, and it sees no reason to place a greater restriction on the listener who prefers for his personal convenience the relay system.

Summing up, it would appear that the recommendations of the Beveridge Committee, so far as they concern technical aspects of broadcasting in Great Britain, are both reasonable and sound. Their acceptance and implementation would go a considerable way towards achieving the object of the British Broadcasting Corporation, namely, to enable everyone in Great Britain to receive broadcasting and television services which are both technically adequate and of reasonable diversity.

BIOLOGY IN "CHAMBERS'S ENCYCLOPÆDIA"

Chambers's Encyclopædia
New edition. Vol. 1: A–Autonomy. Pp. xix+848. Vol. 2: Autun–Camorra. Pp. xv+816. Vol. 3 Camouflage–Confession of Faith. Pp. xiv+840. Vol. 4: Confirmation–Educational Psychology. Pp. xv+820. Vol. 5: Edward–Franks. Pp. xiv+856. Vol. 6: Franquelin–Heine. Pp. xv+824. Vol. 7: Heinrich–Izvolsky. Pp. xiv+820. Vol. 8: J–Majesty. Pp. xv+840. Vol. 9: Major–New York. Pp. xv+856. Vol. 10: New Zealand–Pola. Pp. xv+824. Vol. 11: Poland–Rosicrucians. Pp. xv+840. Vol. 12: Roskilde–Spahi. Pp. xv+796. Vol. 13: Spain–Tsushima. Pp. xv+792. Vol. 14: Tuamoto–Zygote. Pp. xiv+856. Vol. 15: Indexes and Maps. Pp. x+815. (London: George Newnes, Ltd., 1950.)
15 vols., £42 10*s*. 0*d*.

AN accurate picture of the biological contributions in a series of volumes conceived and executed on so grand a scale as "Chambers's Encyclopædia" is not easy to paint. It could be attempted by citing a long list of the distinguished contributors and by tabulating the subjects dealt with in their alphabetical arrangement. These lists might be helpful as an introduction to the total contents of the volumes; but both would be so lengthy that most readers would probably be overcome by ennui before reaching the end. For this reason it is probably enough to say, first, that leading men of science and other scholars were consulted when the general plan of the encyclopædia was being drawn up and that the advisory editors in biology were Profs. W. H. Pearsall (botany) and Munro Fox (zoology) of the University of London; they were ably assisted by Prof. F. J. Lewis, formerly professor of botany at Fouad I University, Cairo (botany), and Sir Norman Kinnear, until recently director of the British Museum (Natural History) (zoology); secondly, that in the first of the fifteen volumes there are at least twenty-seven biological contributors, most of whom have names known all over the world; and, thirdly, that the managing editor has wisely decided that though the majority of the contributors to an encyclopædia primarily written for British readers should be British, contributions on particular topics should be included from recognized authorities, professional or amateur, in any part of the world whether Britain, Baghdad or Brazil.

A superficial idea of the range and quality of the contributions may be obtained by random gleaning in the different volumes. In volume one, for example, the first biological contribution describes existing aard-varks. The third gives a short account of Abbotsbury, the Dorset home of the famous swannery. Later follows a good account of abyssal fauna with appropriate line drawings; descriptions of the Acanthocephala and Acanthodii are similarly illustrated. When the Algæ are considered, however—the contributor being, not unexpectedly, Prof. F. E. Fritsch—besides three useful series of line drawings there is an accompanying plate in colour with reproductions of original paintings of seaweeds by Shirley Townend. A later article on artificial insemination in human beings shows the restraint with which this and other controversial subjects are treated throughout the Encyclopædia.

In the "B's" a full account of bananas, including details of cultivation, harvesting, transport and ripening, pests and diseases, is surprisingly followed by a cavalier treatment of buttercups. The section dealing with the behaviour of animals, on the other hand, includes separate contributions by two specialists. A lengthy and well-written account of biophysics leaves one wondering why no separate description of biochemistry is given; the omission of an article on biological control is also puzzling. The section on birds leaves little to be desired and, good as is the text, will be chiefly remembered by the plate which reproduces E. A. R. Ennion's paintings of uncommon birds in flight.

In the "C's" an article on cabbages will satisfy both the botanist and the gardener; the former may later be perturbed to find that Canada balsam is not included. He may also wonder why a long and interesting contribution on bulbs is not supported by a reference to corms. The zoologist will welcome a plate containing some original line drawings of crustaceans by F. Pattisson, and another, in colour, with reproductions of paintings by D. Fitchew, to illustrate an admirable article on colour in animals which not only deals with the general principles of adaptive coloration but also with the chemical and physical nature of colours and with colour change.

Under letter "D" a concise account of digestion is followed by an interesting and well-illustrated contribution on the dinosaur. A long article on ducks is to be expected in a British encyclopædia, as is the one on dogs; why dogs merit many illustrations and ducks none is not clear.

So, letter by letter, one could continue to describe the biological contributions in an encyclopædia which, despite minor criticisms, is a joy to examine. A detailed description of the evolution and antiquity of man, for example, is a feature of the "M's"; this makes the absence of reference to the growth of speech under the "S's" rather surprising. Among the more common letters of the alphabet is a simple account of vestigial organs and a detailed description of vitamins, including the manner in which the latter are prepared industrially; an interesting biography of Alfred Russel Wallace; a long description of water relations in plants, which may not make easy reading for non-botanists; the surprising omission of reference to yolk and yeast; a friendly and intimate picture of zoos, and, finally, a series of articles on the science of zoology which should satisfy the most pertinacious inquiries of the curious layman.

Taking the fifteen volumes as a whole, the number and worth of the biological contributions make impressive reading which should meet the most exacting demands. Even though particular items are unexpectedly missing in some places, in general there are likely to be few students of biology who will not warmly welcome the appearance of this new "Chambers's Encyclopædia", in which the amount of space to be devoted to each topic has been carefully and, usually, correctly assessed. Besides the ease with which they will find important and fundamental contributions to their own special studies, casual scanning of the pages will provide biological students with a wealth of knowledge in related subjects which they will occasionally need to consult and frequently want to read for their own intrinsic interest.

T. H. Hawkins

A MILESTONE IN CHEMOTHERAPY

Streptomycin

Nature and Practical Applications. Edited by Dr. Selman A. Waksman. Pp. xi+618. (London: Baillière, Tindall and Cox, 1949.) 76*s*. 6*d*. net.

STREPTOMYCIN will go down in the history of chemotherapy as the first proved effective chemotherapeutic agent for the treatment of human tuberculosis, and the earliest really effective one for the treatment of infections due to Gram-negative bacteria. Its discovery also directed attention to the Actinomycetes as a fruitful source of valuable antibiotics, and a source from which further outstanding examples have been isolated during the past two or three years. Whether streptomycin itself is assured of a lasting place in therapeutics is, however, quite another matter. It is not free from toxicity, and its use involves a calculated risk to the patient, while the facility with which many pathogenic organisms acquire permanent resistance to streptomycin is without precedent in chemotherapy. These are very definite shortcomings of streptomycin and prompt one to reflect that in the face of competition from better drugs it may yet share the fate of sulphapyridine, not so long ago the outstanding drug of the times and already the outcast of the pharmacopœia.

The isolation of streptomycin was first announced in January 1944, and production of significant quantities began in August 1946, about 1,000 kgm. being produced in that year. Although the preface opens with the tendentious statement that "probably no other drug in the history of medical science has had such a phenomenal rise as streptomycin", it must be remembered that the problems involved in the production of penicillin by the deep-culture method had been brilliantly solved, and the basic technical knowledge and plant were already available when streptomycin reached the stage calling for large-scale production. Intensive clinical trials followed, and the present volume reviews the widely scattered literature on streptomycin. The book is divided into four sections—covering microbiological and chemical aspects, antibacterial and pharmacological aspects, clinical applications and miscellaneous uses of streptomycin—and is the work of fifty-eight authors, all of whom have made notable contributions to the reseafches reviewed.

In the first section, consisting of six chapters, a historical introduction is followed by two chapters dealing with the nature, nutrition, strain selection and strain specificity of *Streptomyces griseus*. Two chapters review the production, isolation and chemistry of streptomycin, and a chapter is devoted to microbiological and chemical methods of assay.

The second section, consisting of nine chapters, deals with the antibacterial activity of streptomycin *in vitro* and *in vivo*, its use in experimental tuberculosis, and streptomycin-resistance in tubercle bacilli. Absorption, distribution and excretion, together with the general pharmacology of streptomycin, are discussed in two chapters, and it is made clear that, while it is still a problem, the neurotoxicity of the drug is much less evident with the purer preparations now available. Although it is not the only chemotherapeutic agent upon which once-sensitive micro-organisms can acquire dependence, this striking phenomenon is but another of the peculiarities of streptomycin in respect to the ease with which it can be acquired. Here indeed is a

fascinating problem in bacterial genetics, and the interesting observation has been made that concentrations of streptomycin in broth above which streptomycin-dependent variants multiply is the same or very close to those above which growth of the sensitive parent strain is inhibited. It may also be added that streptomycin-dependent organisms cannot produce progressive disease in animals in the absence of streptomycin.

Clinical 'uses' of streptomycin are described in the third section of twenty-six chapters, occupying about half the book. Many of these so-called uses scarcely justify the term, and their inclusion makes this section of the volume very uneven. On the other hand, the chapter dealing with streptomycin in the treatment of human tuberculosis is of outstanding merit as an example of objective appraisal both of the difficulties inherent in the chemotherapy of tuberculosis and of the role of streptomycin in the treatment of various forms of the disease. The concluding section of five chapters deals mainly with applications of streptomycin in veterinary medicine.

The book contains a wealth of knowledge on streptomycin, established despite the haste of its gathering, and will interest a wide range of readers drawn from the fields of microbiology, chemotherapy and clinical medicine, and not merely those with a parochial interest in streptomycin.

J. WALKER

TEN YEARS OF CHROMATOGRAPHY

Progress in Chromatography, 1938–1947

By Prof. L. Zechmeister. Pp. xviii+368. (London: Chapman and Hall, Ltd., 1950.) 45*s*. net.

DURING the decade 1938–47 a number of important advances were made in chromatographic methods, while the original Tswett form has continued to be widely used and has proved to be of the utmost importance in many separations, steroids and vitamins being notable examples. The previous decade had seen the establishment of the older chromatographic methods, and the treatise "Principles and Practice of Chromatography" by Zechmeister and Cholnoky has been accepted as the most authoritative work on the subject. However, its successor, namely, this new book by Prof. L. Zechmeister, has not maintained this high standard. Some two-thirds of the book consists of highly condensed practical details of many separations, the treatment taking the form of abstracts rather than giving a critical evaluation which one expects from a work of this kind. The author has been very thorough and little has escaped him—more than two thousand substances are covered—but it is difficult to find one's way in such a mass of detail. There are a number of tables summarizing data for various important groups. This is a valuable feature and could well have been extended to replace much of the descriptive matter. It is difficult to see why Table 16 dealing with the steroids could not have been arranged like the other tables. In its present form, covering six pages of small print, it is very confusing and is scarcely a table at all.

The new methods are discussed in a short general section which also contains some brief historical notes of interest and a good discussion of stereoisomer separation. In general, the treatment here has been scrappy. The theory underlying adsorption on ion-exchange resins is dismissed in a few sentences, while the theory of frontal analysis and displacement development has not received the attention it deserves, and in the case of frontal analysis is presented in a confusing way (cf. Claesson[1]). The key diagram (Fig. 6) of the two-dimensional chromatogram has been carelessly drawn; the cysteic acid spot is not shown, while other amino-acids, for example, glutamic acid, are not in their correct relative positions. The discussion on adsorbents in Chapter 2 is almost wholly confined to alumina, but there are now so many other adsorbents in common use that there is surely justification for their inclusion.

The bibliography occupies thirty-seven pages as compared with only fourteen in the earlier work. This gives an idea of the rapid progress during 1938–47; but there is little to recommend the collection *en bloc* of all these references at the end of the book.

The reader new to the subject will gain little understanding of the significance of the newer methods, of how, for example, they are now being so widely used in structural studies of proteins, polysaccharides and nucleic acids. This is not entirely the fault of the author, but rather due to delays in publication. No book on a rapidly expanding subject can be expected to have all the latest information; but when publication takes as long as three years, it is inevitable that some of the subject-matter has become obsolete, and that some outstanding developments are not included. As a source of reference this book fulfils a useful purpose; but in order to get an up-to-date picture, the reader will have to supplement the book by reference to various review articles and symposia which have been published during the past two years, such as those on chromatographic analysis[1,2], partition chromatography[3–5] and paper chromatography[6,7].

R. CONSDEN

[1] Discuss. Farad. Soc., No. 7 (1949).
[2] Strain, H. H., *Anal. Chem.*, **22**, 41 (1950).
[3] Biochem. Soc. Symp., No. 3 (1949).
[4] Martin, A. J. P., *Ann. Rep. Chem. Soc.*, **45**, 267 (1948).
[5] Martin, A. J. P., *Ann. Rev. Biochem.*, **19**, 517 (1950).
[6] Clegg, D. L., *Anal. Chem.*, **22**, 48 (1950).
[7] Consden, R., *Nature*, **162**, 180 (1948).

DIRECTORY OF INTERNATIONAL SCIENTIFIC ORGANIZATIONS

Directory of International Scientific Organizations

Pp. 224. (Paris: Unesco; London: H.M. Stationery Office, 1950.) 1 dollar, 6*s*., 300 fr.

ONE of the reassuring aspects of contemporary world affairs is the way in which scientific and technical matters can be, and are, debated on an international level in an objective manner with little or none of that partisan rancour that so often mars discussion in politics, economics, sociology, and even the arts and culture in general. Such international liaison is best obtained through the medium of an organized body, and scientific workers can take pride in knowing that there are few specialist fields of science which are not at present covered by an international organization. In fact, now that such bodies number about two hundred, it has become necessary for the United Nations Educational, Scientific and Cultural Organization to publish a "Directory of International Scientific Organizations".

The volume is divided into three parts: "Basic Sciences", "Applied Sciences" and "Miscellaneous"; the second of these is further sub-divided into agricultural, engineering and medical sciences. Within each division the organizations are listed alphabetically, those limited to a particular geographical area being placed at the end of the appropriate part or section under the heading "Regional". Details pertaining to the organizations are based on a questionnaire sent out to each, asking for information on the following sixteen points: official name, address, nature, aims, governing bodies and officers, membership, commissions, facilities, finances, meetings, voting, publications, relations with other international organizations, short history, bibliography and comments. With regard to 'nature', an organization may be inter-governmental, non-governmental or semi-governmental; the first includes all those established through an inter-governmental agreement or diplomatic convention, and the last those which, though they include governments among their members, were not created by an inter-governmental agreement. An adequate subject index completes the work.

A final minor, but by no means unimportant, point may be mentioned. Why do some of these international bodies inflict us with the all-too-common habit of an uncouth collection of initial capital letters (sometimes making a pronounceable word, a practice which is even more uncouth) as an abbreviation of their full title? Most of us take in our stride FAO, WHO and UNO (though to the French-speaking world it is ONU); but how many can recognize, say, III, URSI or (shades of refrigeration) ICES? The easiest way to decipher these is to glance rapidly down the six pages of contents of the Directory where the abbreviations are put in brackets after the full name of the entry. In all fairness, it must be stated that less than half the organizations are encumbered with one of these monstrous alphabetical arrays. As an aid to such identification alone, this Directory should prove very useful, and as a general work of reference it can be highly recommended.

EARLY SCIENCE AT HARVARD

Some Early Tools of American Science

An Account of the Early Scientific Instruments and Mineralogical and Biological Collections in Harvard University. By I. Bernard Cohen. Pp. xxi+201+32 plates. (Cambridge, Mass: Harvard University Press; London: Oxford University Press, 1950.) 38*s*. net.

AN increasing awareness of the far-reaching effects of science on human civilization has led to a desire to know something of the origins of science. During the past few years the British Society for the History of Science has been formed, and the Department of the History and Philosophy of Science in the University of London has increased its activities. At Oxford and Cambridge the University authorities are taking added interest in their Museums for the History of Science. Nevertheless, at the sixth International Congress for the History of Science, held at Amsterdam last August, it was frequently stressed that there is a dearth of teachers of the subject.

The activity in Great Britain is matched by similar developments in the United States, and Dr. Bernard Cohen, professor of general education and of the history of science in Harvard University, is one of the leading investigators in the United States. This present book, one of several to his credit, has been written around the catalogue of the early scientific instruments placed on exhibition at Harvard in February 1949. Searching through the manuscripts and contemporary records in the college archives to find something about these instruments, Prof. Cohen extracted and recorded in his book all information bearing on the early scientific work at Harvard, so that it is possible to form a tolerably clear picture of the state of science there in the eighteenth and early nineteenth centuries. The difficulties under which the Hollis professors at Harvard worked are clearly discernible. Their instruments and apparatus had to be purchased and, if necessary, repaired in England; and the Atlantic crossing, in those days under sail, took at least two months for the double journey. Much of the purchasing was done by helpful agents or friends, and, as communication was slow, it had to be left to them to select what apparatus they thought might be of use and to consign it to Harvard. The products were thus obtained of the major British instrument makers: Edward Nairne, J. Gilbert, Benjamin Martin, George Adams and W. and S. Jones.

Prof. Cohen is a partisan whose concern it is to establish the pre-eminence of Harvard science and to refute Barrett Wendell's statement that the University had not during the eighteenth century attempted to acquire and publish fresh knowledge; but when part of the evidence for original work cited by Dr. Cohen is a paper by Prof. Samuel Williams on "a very uncommon Darkness in the States of New-England, May 19, 1780", conviction is scarcely carried.

Reading between the lines, we get the impression that the apparatus was not extensively used. The lecture syllabuses which Prof. Cohen quotes at length refer mainly to astronomy and mathematics. These were old-established subjects, which had been taught and studied since classical times and should be distinguished from the newer natural, or experimental, philosophy which was being developed in Europe at the time and was the true forerunner of present-day science. It seems clear that those who received their apparatus unselected, by the grateful, would not have the same enthusiasm for it as those in Europe who were actually devising it and instructing the makers as to its design; and it is possible that much of it remained untouched in the cupboards for long periods.

If we do not agree with the author in his estimate of the worth of the early science at Harvard, we are nevertheless grateful to him for having so carefully collected all the evidence and having presented it in a readable and well-documented form. Besides the chapters dealing with the instruments, there is a chapter on the chemistry teaching, and another on biology and mineralogy. The catalogues and lists of scientific apparatus which form the appendixes of the book (forty-four pages of text and twenty-four pages of illustrations) are extremely useful for those interested in early scientific instruments. It is a pleasing feature that there are photographs of all the forty-six objects described in the catalogue of the 1949 exhibition, and it was a happy idea to illustrate an inventory of apparatus made in 1738 by reproductions of the plates from a book of the period.

H. R. Calvert

Introduction to the Theory of Probability and Statistics

By Prof. Niels Arley and Prof. K. Rander Buch. (Applied Mathematics Series.) Pp. xi+236. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1950.) 32*s*. net.

THIS translation of the third edition of the Danish text can be recommended as a useful and lucid introduction to the elementary mathematical theory of probability for the theoretical physicist. For those who wish to handle experimental observations, however, it provides a less complete account; for it touches but lightly upon regression analysis, sampling, estimation theory and significance tests, and omits the analysis of variance and the design of experiments. The reader is assumed to have an elementary knowledge of calculus, while a short appendix caters for such matrix algebra as is needed in the later chapters.

The first three chapters lay out the foundations of the theory of probability and are outstanding for the perspective in which they place the subject. Chapter 4 deals with random variables and stochastic processes. Chapters 5 and 6 concern means, moments and characteristic functions. Chapter 7 discusses the normal distribution, and the χ^2-, t- and F-distributions. Chapter 8 outlines some limit theorems, including the central limit theorem. Chapters 9 and 10 consider the practical application of the theory, especially the fitting of distributions to observations, but with only a brief discussion on estimation. Chapter 11 deals with the theory of errors, and mentions tolerance limits and fiducial limits without going into the difficulties that arise in interpreting such concepts. The twelfth and last chapter is on least-squares adjustments.

The book is well printed and misstatements and misprints are rare: page 64 wins the prize for the jolliest misprint with "piecewife continuity".

J. M. HAMMERSLEY

Chemical Engineering Plant Design

By Dr. Frank C. Vilbrandt. (McGraw-Hill Chemical Engineering Series.) Third edition. Pp. x+608. (New York and London: McGraw-Hill Book Co., Inc., 1949.) 51*s*.

FOR the benefit of British readers unfamiliar with the earlier editions of this work, it should be explained that 'plant', in the United States, does not refer to single items such as heat exchangers or centrifugals for which the term 'equipment' is used, and consequently this book refers only to the design, construction and location of a complete plant for conducting specified operations. General matter is contained in chapters headed foundations, drainage, piping installation, pumps and pumping, the building, power and power transmission, all of which abound in useful information. Sixty-three pages are devoted to a very full discussion of the construction and use of flow diagrams, and forty to the development of the design. As regards equipment, designers of plant are advised very wisely to make use of standard equipment whenever possible, and a long chapter gives a comprehensive survey of most of the main types of equipment, their relative merits for different applications and their performance data.

The British nation has been frequently accused of failing to develop commercially its scientific ideas. Chemical engineers are well aware that one of the main bottlenecks in this process is the difficulty of obtaining even approximate costs for the equipment they may require and its operation. Following an appeal for data of this type in the United States, many papers were published, and much of the information given is reproduced in the 130-page chapter on preconstruction cost estimating, which is thoroughly up to date and perhaps the best in the book. Its contents are of great value even to British chemical engineers. Is it too much to hope that something similar, with costs in Great Britain, will one day be available?

H. E. WATSON

The Mathematical Theory of Communication

By Claude E. Shannon and Warren Weaver. Pp. v+117. (Urbana, Ill.: University of Illinois Press, 1949.) 2.50 dollars.

THE first ninety pages of this small book contain in highly concentrated form a part of the contribution which Dr. Claude E. Shannon, of the Bell Telephone Laboratory, New York, has made during the past few years to the theory of communication. The remaining pages are devoted to a descriptive treatment of the subject by Dr. Warren Weaver, and most readers will find it advantageous, if not necessary, to give this section prior attention.

In brief, Dr. Shannon establishes a means of measuring the information content of messages and discusses how the statistical structure of language may be changed so as to increase the information content per symbol. He then deals systematically with the encoding process by which messages are changed into suitable signals for electrical transmission, with assessment of the capacity of a channel for transmitting these signals and with the effect of noise on this capacity.

The book is written from the point of view of the electrical communication engineer; but, as revealed in a recent symposium on information theory (see *Nature*, January 6, p. 20), its contents have a much wider significance and are likely to exercise an important influence on work in several other branches of science. Few will find it easy to read, but many should make the attempt.

W. J.

Smithsonian Institution

United States National Museum. Bulletin 50: The Birds of North and Middle America. By Herbert Friedmann. Part 11. Pp. xiii+793. (Washington, D.C.: Government Printing Office, 1950.) 4 dollars.

THIS Part of Smithsonian Institution Bulletin No. 50 deals with the birds of prey, many of which are not easy to identify on account of the different stages of plumage they pass through before becoming fully adult. A golden eagle, for example, does not assume the adult plumage until it is from four to four and a half years old; sparrow-hawks, buzzards and others take about half that time. A few, however, moult straight from the juvenile plumage to that of the adult. In addition, certain species vary much in colour, and in some kinds of buzzard there is a pale, a dark, and a rufous phase of plumage. All this adds to the difficulties of identification; but Dr. Herbert Friedmann has clearly described all the different sequences of plumage and variation in colour. Though the work is restricted to North and Middle America, the author has included in the keys to species some extra-limital forms, which may occur as vagrants. This is an innovation which should add much to the usefulness of this valuable work.

THE SONIC SCATTERING LAYER IN THE SEA

By A. C. BURD and A. J. LEE
Fisheries Laboratory, Lowestoft

UNDERWATER sound investigations carried out during the Second World War in the United States revealed the presence in the oceans of extensive deep layers which interfered with the transmissions of an echo sounder. It was assumed that the layer scattered the sound. Hence these layers have come to be known as 'deep scattering layers'. The resultant trace has the appearance of a false bottom, and occurs at depths of 150–450 fathoms.

Dietz[1] and Hersey and Moore[2] have dealt with the deep scattering layers recorded from the Pacific and Western Atlantic Oceans respectively. The layer descends at about first light, and remains during daylight hours at 150–450 fathoms. In the highly transparent tropical water the layer is, in daylight, typically at about 250–350 fathoms, whereas in the less transparent coastal water off California it lies, in daylight, at 150–250 fathoms. At dusk, a rising towards the surface takes place. On the 18-kc. echo sounder recordings, which form the bases of the two papers mentioned above, about the first sixty fathoms are masked by the length of the transmission signal, and as a result the behaviour of the layers in this region is not revealed.

The American workers have discussed the possibility of the layer being caused by physical phenomena, but come to the conclusion that no known physical phenomenon could account for its behaviour. They suggest that the layers are caused by vertically migrating organisms.

Moore[3,4] is of the opinion that the layer consists of Euphausids. He obtained a density of 1–3 per metre^3 in obliquely hauled nets. He considers that a true estimate of the numbers present would be at least ten times this value, owing to the inefficiency of the plankton net in sampling very active organisms. He has also demonstrated a relationship between the depth of the layer and the depth of extrapolated 'iso-illumination' curves, and finds that the diurnal movements may be in some cases limited by temperature gradients. Lyman[3] has suggested that squids are the cause; but Moore does not accept this. Bodon[5], using three different types of net, also finds Euphausids to be the only animals to appear consistently in quantity in the layer; 25 Euphausids per 100 metres was the average density for vertical hauls in the layer. He also suggests that the Pacific saury (*Cololabis saira*), an oceanic plankton-feeding fish, may be a contributory cause of the layer.

Tchernia[6], who has made extensive cruises in the Mediterranean and Red Seas, and in the Pacific, Indian and Antarctic Oceans, regards the layer as a universal phenomenon. In contradiction to the observations of Dietz, he found that the layer was as well developed in the Antarctic regions as in the other areas. Neither the Antarctic Convergence nor the pack ice represented the limits of the extension of the layer. It should be noted, however, that the echo sounders used by Dietz gave an 18-kc. pulse, whereas the WEA.1 used by Tchernia had a frequency of 24·8 kc. The results of the two sounders may not be exactly comparable. Quoting the findings of Bernard, who has shown that the poorest zone of plankton in June off Algiers is, in daylight, between 300 m. and 350 m., Tchernia records that this is the precise depth at which he and Moore[6] have recorded the layer in the same area. Furthermore, in a personal communication he informs us that he has obtained records of layers which do not migrate diurnally and which he does not regard as biological phenomena.

Raitt[7], working with the deep scattering layer, measured the returning signal with an oscillograph and came to certain conclusions with regard to the size of the organisms comprising the layer. He regarded each peak on the oscillogram as the return signal from a single scatterer, and based his calculations on this hypothesis. Although he suggests that the signals received may be the return from 'swarms' of small scatterers, he does not follow up this argument. Hence his conclusions, with regard to the size of the organisms responsible, are to be held in doubt.

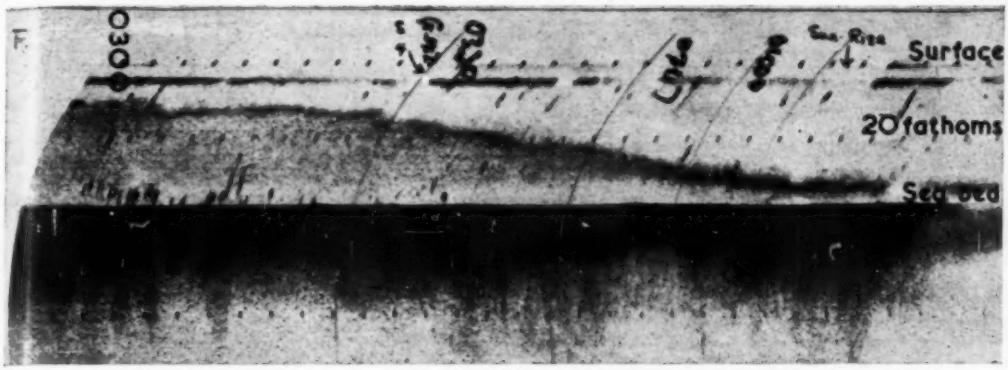
Hitherto, the presence of these layers has only been reported from the very deep water of the oceans and the greater seas. During the past two years, layers of an analogous nature have been detected in the comparatively shallow waters of the English Channel, southern North Sea and the Barents Sea near Bear Island by the echo sounders on research vessels of this Laboratory.

The first of these layers recorded in British coastal waters was found off Robin Hood's Bay in September 1949. The R.V. *Clupea*, while drifting, recorded on a 14-kc. echo sounder a compact layer which was not of very great density, and which rose from a depth of about 45 ft. to about 35 ft. in the hour before sunset. After this the trace was lost, and in a search over the area the layer was not recorded again. It is probable that the organisms had dispersed in the dark.

During the spring and summer of 1950, layers were recorded extensively in the English Channel on the 14-kc. and 30-kc. echo sounders of the R.V. *Sir Lancelot*. One trace extended from the Scillies to east of Start Point, a distance of about seventy miles. A description of the behaviour of the layer recorded during the day and night of June 14–15 may be taken as a typical example.

The layer was first observed lying close to the bottom at 1800 hr. G.M.T. on June 14. The depth of water was 40 fathoms and the top of the layer was recorded at 36 fathoms. The layer rose slowly off the bottom until at 2014 hr. the top edge of it was recorded at 27 fathoms. At sunset, 2027 hr., it had risen to 22 fathoms, and by 2209 hr. it was at 5 fathoms below the surface; after this time it dispersed and could not be detected again until 0100 hr., when it became apparent at 12 fathoms. At 0310 hr. the top of the layer was at 14 fathoms and at 0412 hr. (sunrise) at 33 fathoms (see accompanying illustration). The layer remained about this level, which was close to the bottom, throughout the daylight hours.

During these twenty-four hours of observations, hauls were made with various gears in order to catch the trace makers. The Petersen Young Fish Trawl was the most successful, giving for the first time



Trace of the scattering layer off Lizard Head, June 15, 1950, recorded on a 14-kc. echo sounder of the R.V. *Sir Lancelot*. Migration towards the bottom is shown in daylight. The horizontal distance between dots represents three minutes. The vertical interval is 20 fathoms. Other traces, probably pilchards, can be seen near the bottom on the left and occasionally elsewhere

some definite information on the composition of a layer. A total of eight hauls was made, of which five were in the layer, two above it, and one on the edge of the layer. A depth recorder was used to ascertain the depth at which the trawl had been fishing.

The catches consisted of larval fish, *Calanus*, decapod larvæ, medusæ, *Sagitta* and *Eupagurus* larvæ. Of these organisms the only ones which appeared consistently in similar numbers in each of the hauls in the layer were the fish larvæ. The other organisms showed patchiness, many being caught in one haul and few in another. For example, in one haul of 15 minutes duration, 488 *Eupagurus* larvæ were captured, while in another haul of the same duration only 21 were caught. The nature of the trace was a homogeneous cloud which might not have been producible by these other organisms. The greatest total biomass in the layer was that of the fish larvæ, of which 70 per cent were young pilchards 11·5 mm. long, and about 10 per cent *Crystallogobius* sp., 12·5 mm. long, both of which species possess air bladders, those of the latter measuring about 3 mm. in length.

Very small bubbles of air are known to be excellent scatterers of underwater sound, as a gas has a markedly different density and compressibility from water. Such bubbles have an 'effective diameter' many times that of fish flesh of the same actual diameter. The presence of the air bladders in these fish will therefore increase their scattering surfaces considerably, and because of this they will be the most efficient scatterers of the organisms in the layer.

There were more fish larvæ in the hauls in the layer than in those above it, but when statistical tests were applied the numbers were not quite significantly different. This may be due to a sampling error and also to the small numbers of hauls performed. Despite this, however, the results, when related to the other evidence, suggest that the layers in the Channel were probably caused by large concentrations of young pilchards and other fish larvæ.

In August the appearance of the layer was slightly different. Previously it had appeared as a homogeneous cloud-like trace, but now it had a spottiness superimposed on it. When a Heligoland larva net was hauled through the layer, a number of young pilchards about 5 cm. long was obtained. It is uncommon to catch any young fish in this slowly hauled gear unless they are present in very large quantities. The spotted character of the trace may be related to the increase in the size of some of the pilchards comprising the layer.

During plankton sampling near Flamborough Head in May 1950, a layer was recorded near two plankton stations only. The zooplankton as caught by the Hensen net was more or less evenly distributed over the whole area. This would seem to rule out the zooplankton as being the trace maker on this occasion.

Again, in the southern North Sea in July, when the R.V. *Sir Lancelot* was engaged in trawling experiments, a layer was recorded on the echo sounder when the trawl was being hauled. Thousands of small gobies were found trapped between the knots of the meshes and may have caused the layer in this case.

Early in October 1950, the R.V. *Ernest Holt* was working in the Barents Sea, near Bear Island, where traces were recorded on the echo sounders which did not resemble those known to have been produced by cod. The greatest extent of the trace was about twenty miles. These traces were recorded on both 10-kc. and 14-kc. echo sounders, and on four occasions were seen to descend from near the surface to the bottom, during the 2¾ hours between nautical twilight (sun's centre 12° below the horizon) and sunrise. The depth of water varied between 40 and 95 fathoms. Between 1¼ and 2¾ hours after sunset, that is, during the period between civil twilight (sun's centre 6° below the horizon) and nautical twilight, these traces were observed to ascend from the bottom to near the surface. The rate of descent at sunrise was observed to be quicker when the sky was clear than when it was overcast. Parts of the trace descended at different rates, suggesting that different organisms, which were sensitive to differing light intensities, were present.

In order to catch the organisms, various attempts were made to tow nets in the trace, but without success; other evidence showed the presence of herring, however. The stomach contents of cod caught in the localities where this type of trace was observed showed that these fish had been feeding on young herring 10–12 cm. long, which were also found between the meshes of the trawl. Commercial trawlers reported that herring on the sea surface were washed inboard through the scuppers during the hours of darkness.

It seems reasonable to suppose that the young herring were at least partly responsible for this type of layer. The herring themselves were feeding on

Calanus and Euphausids, and it is not known whether these latter contributed to the trace.

In summarizing the observations on the scattering layers in the sea, we conclude that no generalization is possible as to their cause. However, in the above-mentioned shallow waters there are layers which are: (1) diurnally migrating and analogous in behaviour to some of the deep scattering-layer observations of the American authors; (2) of wide occurrence, being present in the English Channel, southern North Sea, and the Bear Island area; (3) at times very extensive, stretching over 70 miles in the western English Channel and 20 miles at Bear Island; (4) of relatively short existence in comparison with the deep scattering layer; (5) probably caused by young fish 12 mm.–12 cm. in length, their air bladders playing a great part in rendering them more liable to interfere with the transmissions of the echo sounder.

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WINDS AND TURBULENCE IN THE UPPER ATMOSPHERE

IT was at one time thought that winds and mixing of the atmosphere occurred mainly below about 12 km., where the temperature was known to decrease upwards, and that above this level, in the so-called stratosphere where the temperature was thought to be independent of height, the atmosphere was considered to be more or less at rest and stratified in horizontal layers of uniform density. At intervals, observations of self-luminous objects such as meteor trails and luminous night-clouds have suggested that the atmosphere at heights of about 100 km. is turbulent, and even that uniform winds occur there. These observations are infrequent and present such an incomplete picture of the upper-atmospheric motions that meteorologists have not been in a position to try to explain them. Recently, however, several new radio methods have been developed by which the turbulent and wind-like motion of the ionosphere can be investigated, and, since these methods do not depend on the chance occurrence of some self-luminous phenomenon, it appears as though they may soon provide a reliable description of upper-atmospheric motions which meteorologists can then attempt to explain.

With the object of collecting and comparing results of the radio measurements and presenting them in outline to the meteorologists for their consideration, a Geophysical Discussion on "Winds and Turbulence in the Ionosphere" was held at the Royal Astronomical Society on February 23, with Mr. J. A. Ratcliffe (Cavendish Laboratory, Cambridge) in the chair. The radio methods described all depend on the recognition of some irregularity in the ionosphere and then on measurements of the rate at which it moves either in a turbulent irregular way or horizontally with a wind-like motion. The experimental methods differ in their ability to detect and use irregularities of different size and in different regions of the ionosphere.

Dr. W. J. G. Beynon (University College, Swansea) gave a short account of the observations of G. H. Munro[1], who worked in Australia and used ordinary ionospheric sounding equipment at points separated by tens of kilometres. Munro identified certain large-scale phenomena on the P'–f curves and found that they were often approximately repeated, but with a time lag, at the different observing points. He deduced that there were irregularities in the horizontal distribution of ionization in the F-layer with a 'size' of about 400 km. and that they appeared to move with velocities of the order of 100–200 m./sec. The movement was predominantly towards the east; there did not appear to be any regular diurnal change in the direction of movement, but a seasonal variation, with a rather sudden change at the equinoxes, was noticed. Dr. Beynon himself has observed similar movements in the F-layer: during the Second World War[2] when he found that sometimes ionospheric irregularities which appeared to influence the transmission from Zeesen (Berlin) to Slough would also influence waves reflected vertically at Slough some time later; and in more recent experiments made between Swansea and Slough (230 km. distance), when he has found that the direction of motion sometimes changes in the course of one day.

Some experiments of a different nature, which seem to throw light on the same large-scale irregularities in the F-layer, were described by Mr. E. N. Bramley (Radio Research Station, Department of Scientific and Industrial Research). He has measured the direction of arrival of a short train of radio waves reflected from the ionosphere at nearly vertical incidence, and has deduced that the layers of constant ionization are often tilted through angles of a few degrees. Comparison of the observations made at points separated by about 27 km. has led to the conclusion that similar tilts occur at the two places but with a time lag which corresponds to the passage of a disturbance overhead. These disturbances have a size of about 100–500 km. and move with a velocity of about 35–350 m./sec., with a general tendency to move towards the east. Mr. Bramley stressed that observations of this kind lead only to a knowledge of changes in the distribution of the ionization and do not necessarily imply the presence of winds in the atmospheric gases.

Another method of investigating the F-layer was explained by Dr. A. C. B. Lovell (University of Manchester), and also by Mr. Ratcliffe, who described results obtained by Mr. M. Ryle (Cavendish Laboratory, Cambridge). In this method the waves received at the ground from a 'radio star' on wave-lengths of 3·7 m. (Lovell and Ryle) and 6·7 m. (Ryle) are studied. Their amplitude is often found to vary with time in a way analogous to the scintillation of optical stars, and experiments with spaced receivers[3] have shown that these variations are produced by irregularities in the terrestrial ionosphere having lateral dimensions of the order of 5 km. These irregularities are associated with the conditions in the F-layer which produce 'spread-F echoes' on ionospheric sounding equipment. Dr. Lovell thinks that there is some evidence that the ionospheric irregularities are smaller towards the polar regions.

It has been suspected[4,7] for some time that the 'scintillation' of the radio stars is caused by regular movements of the ionospheric irregularities, and recent experiments using spaced receivers have con-

firmed the presence of steady movements of the irregularities with speeds of the order of 100 m./sec. A surprising result, mentioned by Mr. Ryle, is that the direction of the wind along the east–west line has, on some occasions, been found to reverse within a time of about thirty minutes.

Mr. G. J. Phillips (Cavendish Laboratory, Cambridge) described measurements on the *E*-region at a height of about 100 km. He used the method of S. N. Mitra[5] in which short trains of radio waves are received, after reflexion from the ionosphere, on three receivers situated close to the transmitter and separated from each other by distances of the order of 100 m. From the fading observed at the three receivers, it is possible to deduce that the *E*-layer has an irregular structure in which the smallest size of irregularity is about 200 m., and that the irregularities move with random turbulent speeds of about 1 m./sec. On most occasions the random movement is almost completely masked by a regular wind-like movement with a speed of the order 80 m./sec. Measurements of the speed of this wind have been made on three days every month over the past two years, and although there is a considerable amount of irregularity in the behaviour, there also seem to be some regular features—for example, the behaviour in the summer months has been more regular than in winter, and has shown a wind predominantly towards the west by night and towards the east in the midday hours. Somewhat similar results have been obtained by workers using the same experimental methods in Washington, D.C. A harmonic analysis of the results shows a statistically significant semi-diurnal solar tide. The horizontal tidal motion found is represented by a vector with a clockwise rotation having a magnitude of 20 $\pm$ 10 m./sec. and directed towards the east at 0630 hr., but no statistically significant lunar tidal component has been found. There is some evidence to show that the *F*-layer has a fine structure of the same sort of size as that in the *E*-layer, and that it moves with similar velocities. On some occasions the velocity measured with waves reflected from the *E*-layer is reversed within half an hour, but it is just possible that this reversal represents phenomena occurring at two different heights.

Dr. Lovell summarized work done by L. A. Manning and others[6] in the United States. He measured the Doppler effect on waves reflected from meteor trails and deduced that it corresponded to a wind with a velocity of the order of 30 m./sec. The height of these trails was known to lie somewhere in the region of 80–100 km. Most of the wind-like movements were towards the north-east or to the south, and there were some rather sudden changes of direction which might possibly correspond to different directions at different heights. Dr. Lovell also mentioned some experiments made by his own colleagues, in which the rapid fading of the echo returned from meteor trails was studied, and from which it was deduced that there were irregular turbulent velocities of about 25 m./sec. at levels of about 90 km.

Mr. Ratcliffe summarized the radio evidence as shown in the accompanying table.

Approximate heights	Horizontal size of irregularity	Turbulent velocity	Drift velocity	Worker and remarks
>300 km.	5 km.	—	100 m./sec.	Lovell & Ryle. Some reversals within 30 mins. (Ryle).
250 km.	500 km.	—	100 m./sec.	Munro, Beynon. No diurnal variations. Seasonal changes near equinoxes. Movement predominantly towards east.
250 km.	100–500 km.	—	35–350 m./sec.	Bramley. Movement towards east.
250 km.	$\not<$ 200 m.	1 m./sec.	80 m./sec.	Phillips.
100 km.	$\not<$ 200 m.	1 m./sec.	80 m./sec.	Phillips. Some regularity in diurnal behaviour repeating over 2 years and in America. Some rapid reversals.
90 km.	Ionized meteor trails	25 m./sec.	—	Lovell.
90 km.	Ionized meteor trails	—	30 m./sec.	Manning. Reversals of velocity possibly related to small changes of height.

Discussing these results from the point of view of a meteorologist, Prof. P. A. Sheppard (Imperial College of Science and Technology, London) emphasized that temperature difference provides the most probable source of the energy required for the wind-like motions. If geostrophic winds with a velocity of about 50 m./sec. in an east–west direction were to be produced by a horizontal temperature gradient in a layer of thickness 10 km., this gradient would have to be of the order of 1° C. per 100 km. in a north–south direction. In a changing pressure field it is also possible to have an isallobaric wind which flows from a place where the rate of change of pressure is high to a place where it is low. If winds of velocity 50 m./sec. were produced in this way in a layer of thickness 10 km., there would have to be a temperature gradient changing at the rate of 4° C. per hour per 1,000 km. Even near sunrise a differential heating of this magnitude is unlikely. It can be shown that Eulerian winds, flowing from regions of hot air to regions of cold air, would require a diurnal temperature variation of 10° C. and would be accompanied by a marked seasonal variation of wind. Prof. Sheppard stressed that it is difficult to explain the reversals of wind which have been reported, and he suggested that the most likely explanation is that there is a quasi-geostrophic flow in different directions at different levels and that the radio observations do not always apply to the same level.

In the free discussion which followed, Mr. Ryle pointed out that even if the observations made with waves reflected from the ionosphere could be explained in terms of reflexions from different levels at different times, this is not a possible explanation of the reversals of velocity deduced from observations of radio stars, since in that case the radiation has passed through the whole of the ionosphere. Other speakers stressed that, although the radio observations detect changes in the electron density, they do not necessarily imply the bodily movement of the atmosphere, and in this connexion Dr. R. E. Scorer doubted whether there is any mechanism which might reasonably be expected to produce a wave-

like disturbance in the ionosphere such as that suggested by D. F. Martyn[8].

The meeting provided an excellent opportunity for the bringing together of workers in different branches of this subject, and the Royal Astronomical Society is to be congratulated on choosing such a live subject for discussion. The two most important points which emerged from the discussion were: first, because the wind may change in an important way with height, it is essential to measure the height accurately; and secondly, horizontal movements of irregularities of electron density do not necessarily imply bodily movements of the air.

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PLANT CHROMOSOME-RACES AND THEIR ECOLOGY IN GREAT BRITAIN

By Dr. G. HASKELL

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SINCE the "Merton Catalogue"[1] appeared, botanists have had in their hands a list of the chromosome numbers of British flowering plants. It provides a starting point for studying the relations between cytology and various aspects of the flora, such as taxonomic problems, geographical distribution and ecology.

Species may occur with more than one chromosome number, having either a few chromosomes more or less than the normal (aneuploid series), or the numbers are in multiples of each other (polyploid series). Now Darlington[2] has pointed out that sometimes polyploids occurring within the species are indistinguishable from one another except on the basis of distribution, while others may show size differences of a general character. Therefore, if one considers those species in the British flora containing a polyploid series which taxonomists have not assessed as separate species on morphological grounds, such chromosome-races, as they can be termed, may yield information on the effect of chromosome doubling in relation to plant ecology.

Chromosome-races can consist of autopolyploids which may have originated from relatively homozygous diploids or from hybrids between varieties or subspecies of a diploid species[3]. Valentine[4] has discussed the classification and nomenclature of different kinds of polyploid series. Sometimes, as in *Valeriana*, individual chromosome-races within the species recognized cytologically can also be identified by pollen size and stomatal index, which increase with rise in chromosome number. Some of the higher chromosomal types within the species have later flowering. Recently, cytologists have taken precautions to record the habitats of the plant material which they examine, whereas earlier records gave no indication of these.

Some examples can be given which show that there is a relation between chromosome-races and the ecology of the species. For example, Hancock[5] found that the three chromosome-races of marsh bedstraw (*Galium palustre*) occupied different habitats. Diploids ($2n = 24$) in Oxford occurred in damp places which dried out in summer. Tetraploids ($2n = 48$) in Devon occupied intermediate habitats, often being submerged in winter and in soil remaining damp in summer. The octoploids ($2n = 96$) in Oxford lived in permanently damp zones and reproduced vegetatively by creeping shoots and roots at the nodes.

In Europe the common whitlow-grass (*Erophila verna*) was found by Winge[6] to consist of several chromosomal types, with a relation between chromosome number and external form. He divided the collective species into four eco-species, two of which occurred in Britain. These are *E. duplex* ($2n = 30$ to 40), which prefers pastures, gravel-pits and roadsides and is so far recorded only in England, and *E. quadruplex* ($2n = 52$ to 64), which Winge found only in Scotland, growing in low-lying grassland and bogs. It is a much larger plant and perhaps better fitted in competition for light with other species in denser plant associations. In general in *Erophila*, higher chromosome numbers go with larger plants; but the higher chromosome types are handicapped by later flowering and inferior seed setting. No doubt further sampling of the *Erophila* complex in Britain will reveal information as to whether (as seems possible) chromosome number in this species gradually increases northwards.

Lövkvist[7] in southern Sweden found that there is both a polyploid and an aneuploid series within the species of lady's smock (*Cardamine pratensis*), as in *Erophila*. Plants with different chromosome numbers occur together in meadows, but there is a regional distribution. Plants with lowest numbers ($2n = 30$) occur in the higher drier parts, while lower parts contain the intermediate races ($2n = 56$ to 68). The highest chromosome-races ($2n = 72$ and 76) are near or in water. This suggests that here there is a direct relation between chromosome number and water content of soil among members of the same species in local competition. A plant from the light soil of the former John Innes site at Merton was $2n = 32$ [8], while plants from three rather wet situations near Cambridge[9] were $2n = 56$, indicating that a similar situation probably holds true in Great Britain.

There are two British chromosome-races of parsley piert (*Aphanes arvensis*) according to Walters[10]. The diploid (*A. arvensis* s. str. $2n = 16$) is a sexual form indifferent to soil acidity and occurring in forty-three vice-counties[11], while the hexaploid, now known as *A. microcarpa* ($2n = 48$), is apomictic and restricted to acid soils; it occurs in thirty-seven vice-counties. Lesser celandine (*Ranunculus ficaria*) occurs in all vice-counties and comprises four chromosome-races, including a sexual diploid ($2n = 16$) producing viable seeds and lacking tubers in the axils of stem leaves, and a tetraploid (var. *bulbifera* $2n = 32$) with these tubers. It rarely has good seed, and reproduces entirely vegetatively by root tubers. According to Turrill[12] these two races probably have an unequal range in Britain: both occur in the counties of Middlesex, Surrey and Buckinghamshire; but only the diploids have been found in parts of Devon and Somerset. Further records of such chromosome-races would be welcome.

Darlington and Mather[13] have re-emphasized that simple chromosome doubling produces both a genetic change and simultaneously establishes a discon-

tinuity by creating a new form which will not cross with the old. They point out that a single colonizing polyploid individual can produce variation impossible to a solitary diploid, and so when there are sudden opportunities for colonization to occur, as after an ice-age, the new polyploid can step in and quickly acquire a large range from which its diploid parent is excluded. Evidence for this is provided by the two chromosome-races of valerian (*Valeriana officinalis*) studied by Skalinska[14]. The tetraploids ($2n = 28$) are limited to southern England south of a line from the Bristol Channel to the Wash, and roughly corresponding to the 62° F. July isotherm, while the octoploids ($2n = 56$) extend as far north as West Inverness. Within their common area, for example, Gloucestershire, the two chromosome-races are ecologically separated, tetraploids being confined to dry, limy or chalky habitats in hilly regions, while octoploids grow at lower altitudes in moist soil, along river sides and on ditch banks. Yet farther north, where octoploids alone occur and have spread after the ice retreated, there are variants which grow in both dry and wet places. In this instance an *old* tetraploid has behaved as a relative diploid.

There are three British chromosome-races of watercress (*Nasturtium officinale*), the species occurring in all vice-counties[11]. Manton[15] has separated them on morphological as well as cytological grounds. The diploid (*N. officinale* s. str., $2n = 32$) is an annual with bright green leaves while the tetraploid is the perennial winter watercress (*N. microphyllum*, $2n = 64$), recognized by its purplish-brown leaves in cold weather. Recent but still incomplete records of their distribution[16] suggest that the diploid tends to occur more in the western part of Britain while the tetraploid occurs more to the east; both species overlap in midland counties. Perhaps the diploid occurs in areas with higher mean annual rainfall than the tetraploids. On the other hand, the same records for the sterile triploid show an irregular but wider range of distribution from east to west; it may be absent where both parents occur and be present where both are absent. Field studies in Oxford have, however, failed to show ecological preferences between diploids and tetraploids[12].

Many other chromosome-races require investigation. For example, in Britain there are two closely related *Arum* species: *A. neglectum* ($2n = 63$) is a nonaploid confined to the south coast of England, while the common cuckoo-pint (*A. maculatum*, $2n = 56$ and 84) occurs throughout Britain with a sharp delimitation at latitude 56° N. Salisbury[17] has pointed out that probably the different species distribution is due to differences in times of leaf emergence. But we do not as yet know what kinds of distribution the two chromosome-races of *A. maculatum* have in relation to each other.

Investigations have also been made into the cyto-ecological relations of closely related species within a genus, members of which can still sometimes hybridize. Thus, Fitzpatrick[18] has established a relation between ploidy and normal habitats among British meadow-grasses (*Glyceria* spp.), all of which are morphologically distinct. The diploid species (*G. declinata*, $2n = 20$) is most drought-tolerant, living in dried-up ponds and cart ruts, while the two tetraploid species (*G. plicata* and *G. fluitans*, $2n = 40$) prefer wetter habitats such as ditches and stream edges. The hexaploid species, *G. maxima* ($2n = 60$), is a typical constituent of reed swamps[12].

The relation between chromosome-races and ecology can also be observed in Pteridophyta. For example, Manton[19] has found that in the common polyploidy fern (*Polypodium vulgare*) the diploid ($2n = 74$) usually occurs on limestone habitats in south-west England and in Yorkshire. This race, known as the variety *serratum*, has its dormant season in summer, putting out new fertile fronds in August or September, while the tetraploid ($2n = 148$) is earlier, producing new leaves in May and June. The hexaploid ($2n = 222$) is a large plant with thicker leaves and has an extended season from summer to autumn; it prefers moister climatic conditions, and is the commonest type in Ireland, Wales and south-west England and the only race on Jersey.

Where there are ecological differences between chromosome-races within a species the general trend becomes clear. Within the species, lower chromosome multiples prefer drier habitats and there is a progressive trend through intermediates to the highest polyploids, which prefer moist or wet habitats. Aneuploidy is not so important in this respect as polyploidy. It remains to be determined how this has come about, the actual physiological relationships involved, and whether the phenomenon is related to a change-over from sexual to apomictic or vegetative methods of reproduction which so often accompany higher polyploidy[3].

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OBITUARIES

Prof. Cyril Batho

We regret to record the death of Prof. C. Batho, which occurred at his home in Birmingham on March 23, after an illness which had lasted some months. Prof. Batho retired only last year from the Beale chair of civil engineering in the University of Birmingham, and was afterwards accorded the title of emeritus professor.

Born in Liverpool on June 21, 1885, Dr. Batho was educated at Liverpool College and at the University of Liverpool, where he later spent some time in postgraduate research. He was appointed to a lectureship in civil engineering at McGill University in 1908 and thereafter spent two years in postgraduate study at Berlin and Charlottenburg, returning to McGill University in 1911 as assistant professor. In addition to his work at the University, he acted for a period as an assistant design engineer on the Quebec Bridge.

Following the outbreak of the First World War in 1914, Prof. Batho became research officer to the Canadian Machine Gun Corps and, later, served as senior technical assistant at the Royal Aircraft Establishment, Farnborough. After spending a short time as lecturer at Trinity College, Cambridge, he returned to McGill University in 1919 as associate professor of applied mechanics and hydraulics. In 1924 he was appointed to the chair of civil engineering in the University of Birmingham, where he remained until his retirement in 1950.

Prof. Batho was responsible for a considerable amount of research dealing with reinforced concrete and various aspects of structural engineering, his main interest being in statically indeterminate structures and in riveted and other connexions. He was chairman of the Midland Association of Civil Engineers during 1932–34 and a member of the Steel Structures Research Committee from 1929 until 1936.

A bachelor and of a retiring disposition, Prof. Batho was a man of wide cultural interests. His devotion to music and the arts led him, in the years gone by, to pay numerous visits to Continental centres.

Prof. Giovanni Giorgi

On August 19 of last year the scientific world suffered a great loss by the accidental death, through drowning, of Prof. Giovanni Giorgi, of the University of Rome, widely known as the proposer and champion of the M.K.S. system of electrical units which bears his name.

Prof. Giorgi was born at Lucca on November 27, 1871, took his degree in engineering at Rome in 1893 and immediately devoted himself to the study of theoretical physics and mechanics. He explained his scheme of units in 1901 in a paper published in *Atti della Associazione Elettrotecnica Italiana*, and submitted three years later to the St. Louis Congress of the International Electrotechnical Commission. The Giorgi system was officially adopted by the Commission in 1935: it is an extension of the practical system (amperes, volts, henries, farads, etc.) to include electric and magnetic fields. In Giorgi's words, "this will result in a great simplification of all practical calculations and of the learning of electrical theory in the schools. A great deal of waste of time and intellectual fatigue will be saved."

In 1903 Prof. Giorgi published an important paper on methods of studying and representing sinusoidal alternating currents, and he followed this by several papers on electrical transients. He gave a precise theoretical basis to Heaviside's operational calculus.

Giorgi was the author of more than three hundred and fifty papers on physical and mathematical subjects. All his writings are characterized by clarity of ideas, simplicity of exposition and elegance of expression.

We regret to announce the following deaths:

Dr. E. E. Day, formerly president of Cornell University, a distinguished economist and statistician, on March 23, aged sixty-seven.

Mr. G. E. Pearson, formerly chairman and governing director of the Wellcome Foundation, Ltd., on March 29, aged eighty-two.

NEWS and VIEWS

Mathematics at the Queen's University, Belfast: Prof. T. G. Room, F.R.S.

Prof. T. G. Room, of the University of Sydney, who has been appointed to the chair of pure mathematics at the Queen's University, Belfast, was educated at Alleyn's School and at St. John's College, Cambridge. He held an assistant lectureship in mathematics at the University of Liverpool during 1925–29, and was elected to a fellowship at St. John's College, Cambridge, in 1927. From 1929 he was a University lecturer in mathematics at Cambridge, until he was appointed to the chair of mathematics at Sydney in 1935. At Cambridge his geometrical powers developed under the guidance of Prof. H. F. Baker, and he soon began to make important contributions to the subject. Attracted by the synthetic methods of Reye, and interested in the incidence properties of geometrical configurations, he set out to discover generalizations, in higher space, of theorems such as that of the double-six of lines in the solid, and of the set of five associated lines in a four-fold. In this connexion he was naturally led to investigate the properties of projectively generated manifolds in higher space. In 1939 he published a classical treatise on the "Geometry of Determinantal Loci", giving a systematic account of the subject, of basic importance for further advances. The projective properties of these loci are established by a powerful use of synthetic methods, together with simple matrix algebra. This branch of geometry is by no means exhausted, and Prof. Room is still extending our knowledge in this field. Prof. Room was elected to the Royal Society in 1941.

Civil Engineering at Melbourne: Dr. A. J. Francis

Dr. A. J. Francis, who has been appointed to the chair of civil engineering in the University of Melbourne, is a graduate of the University of Birmingham, having taken a first-class honours degree in civil engineering in 1934 and afterwards the M.Sc. and Ph.D. degrees of that University. After graduation, Dr. Francis was appointed assistant engineer to the Worcestershire County Council and later joined the staff of John Mowlem and Co. During the last years of the Second World War he served with the Ministry of Home Security and the Admiralty. At the conclusion of the War he was appointed a lecturer in the Department of Civil Engineering in the University of Birmingham, a position which he held until his appointment to the Melbourne chair this year. Dr. Francis has specialized in structural research and has published a number of papers on the structural analysis of reinforced concrete, steel and light-alloy structures. He is married, with three sons, and takes a keen practical interest in music.

Physics Subdivision of the Atomic Energy Project, Canada: Dr. B. W. Sargent, M.B.E.

Dr. B. W. Sargent has been appointed assistant director in charge of the Physics Subdivision of the Atomic Energy Project, Chalk River, Canada, in succession to Dr. W. H. Watson, who last year was appointed head of the Physics Department, University of Toronto. Dr. Sargent has been associated with the Atomic Energy Project since its inception, and in 1945 worked on the heavy-water reactor pile, the first to be built in Canada. Since then, he has been

in charge of the Nuclear Physics Research Branch. After graduating from Queen's University, Ontario, Dr. Sargent went to the Cavendish Laboratory, Cambridge, and was awarded his Ph.D. in 1932 for work on beta-rays emitted by radium and similar substances, in the course of which he discovered an important relation now known as "Sargent's Law". He received the M.B.E. in 1946 in recognition of his research during the Second World War.

International Conference on Phenomenology

An international conference on phenomenology, held in Brussels during April 12–14, enabled a number of philosophers interested in the work of Edmund Husserl and his school to come together in congenial surroundings. Delegates attended from the following countries: Belgium, France, Germany, Great Britain, Italy, Netherlands, Switzerland and the United States. The discussions were noteworthy for the high level of the papers presented, and for the friendly (but by no means uncritical) atmosphere which characterized the whole of the proceedings. The main items included the problem of intentionality, the comparative positions of Descartes and Husserl, scientific knowledge, language, and free-will. Those taking part were particularly gratified at the opportunity of visiting the Husserl-Archiv at the University of Louvain, and of seeing for themselves something of the bibliographical work in progress. Some idea of the magnitude of the task could be gained even from so brief a visit. To Dr. H. L. van Breda is due not only the appreciation of the visitors for such a well-conducted symposium: they all realized how much the whole learned world is indebted to him and his colleagues for carrying through the stupendous task of conserving, transcribing and editing these unique manuscripts.

Science Museum: Past and Future

A special exhibition, entitled "Science Museum: Past and Future", was opened at the Science Museum, South Kensington, London, S.W.7, on April 20, and will continue to be shown during the normal Museum hours (weekdays and Bank Holidays, 10 a.m.–6 p.m.; Sundays, 2.30–6 p.m.) throughout the Festival of Britain. The exhibition tells the story of the development of the Science Museum, a story which began with the Great Exhibition of 1851, among the many consequences of which was the setting up of the South Kensington Museum of Science and Art in 1857; in 1909 the Science Museum began a separate existence and continued to develop into the institution as it is known to-day. A part of the display shows the kind of exhibit which will be found in the new galleries to be opened when present building operations are completed, or later when it becomes possible to build the upper floors of the new Centre Block. A dominating feature of the Exhibition is a group of three large pictures: the Museum in 1857; the Museum district of South Kensington as it appeared from the air recently; and an artist's impression of the Science Museum as it may one day appear when the building, as originally contemplated, extends from Exhibition Road to Queen's Gate. An illustrated handbook, "A Short History of the Science Museum", is on sale at the Museum, price 1*s*.

Law of Copyright

In a Parliamentary written answer, Mr. Wilson, President of the Board of Trade, states that he has appointed a committee "to consider and report whether any, and if so what, changes are desirable in the law relating to copyright in literary, dramatic, musical, and artistic works, with particular regard to technical developments and to the revised International Convention for the Protection of Literary and Artistic Works signed at Brussels in June 1948, and to consider and report on related matters". The committee consists of Lord Reading (chairman), Dr. T. E. Allibone, Mr. J. L. Blake, Mr. G. Bristow Cooke, Miss B. A. Godwin, Sir Henry Gregory, Mr. E. M. Hugh-Jones, Mr. J. P. Lamb and Mr. F. E. Skone James. The secretary to the committee is Mr. H. W. Clarke, of the Patent Office, 25 Southampton Buildings, London, W.C.2.

Applications of Statistics to Archæology

In "Some Applications of Statistics to Archæology", a publication of the Service des Antiquités de l'Egypte (pp. 37+19 figs.; Cairo: Government Press, 1950; P.T. 120), after stressing the scant development that has succeeded the pioneer efforts in such a direction made by the late Sir Flinders Petrie almost three-quarters of a century ago, Oliver H. Myers describes the use of statistical methods in the treatment of archæological data under the following four headings: the relationship of stone and pottery in a stratified site; the sizes of sherds from surface sites in the desert; the hardness of ancient pottery; and the statistical examination of surface sites. The techniques employed include correlation and regression, tests for the significance of the difference between two observed means and, under the fourth heading, elementary combinatorial theory. Although the results of the last depend on some rather arbitrary assumptions and should therefore be treated with reserve, the author has shown that there are problems in archæology that lend themselves admirably to statistical treatment, and he has established his point by example rather than by precept, an approach likely to be effective in attracting the attention of archæologists unfamiliar with the methods of statistics. In such a connexion it may be pointed out that the footnote on p. 32 relating to tests for the significance of a correlation coefficient would probably confuse a beginner. Again, the fact should perhaps be indicated that the test of the significance of the difference between two observed means given on p. 16 is an approximate one (due to Cochran and Cox), to be used under suitable conditions, instead of the exact t-test, when it is desired to avoid the assumption of the homogeneity of the variances. In the example that illustrates the method, however, the variances are almost identical and the use of the t-test would be justified.

Joint Consultation

A broadsheet offering a practical approach to joint consultation in industry has been produced by a study group on behalf of the Institute of Personnel Management. The broadsheet deals only with joint consultation inside industrial establishments and is not concerned directly with that aspect of joint consultation which is part of the established machinery for the negotiation of wages and working conditions between employers and the trade unions. After a historical review of the development of joint consultative machinery in British industry since the First World War, a further section of the broadsheet discusses the reasons why joint consultation is necessary in industry. Then comes much useful and eminently practical advice on the means of intro-

ducing joint consultation procedure into an organization, and this is followed by suggestions for keeping the machinery and spirit of joint consultation alive. The broadsheet also contains details of the constitutions of joint consultative bodies at three firms where joint consultation is successfully practised; these are, the Works Council of the Northern Branch of High Duty Alloys, the Management Advisory Committee of Vauxhall Motors, Ltd., and the Works Council Scheme of Imperial Chemical Industries, Ltd. The broadsheet may be obtained from the Institute of Personnel Management, Management House, Hill Street, London, W.1, price 2*s*. 6*d*.

Use of Plastics in Preparing Fossils

A useful technical article by H. A. Toombs and A. E. Rixon, of the British Museum (Natural History), concerning a new development of the 'transfer method' in the preparation of fossils is contained in the *Museums Journal* (105; August 1950). The early technique of Holm in the preparation of graptolites, whereby the fossil was stuck to a glass slide by means of Canada balsam and the matrix removed by hydrochloric acid, is well known. In 1948 Toombs, by using acetic acid instead of the mineral acids, showed how the method could be applied to most vertebrate remains in calcareous rocks. It was necessary, however, to use a rubber cement instead of Canada balsam, which is attacked by acetic acid. This rubber cement, however, had the disadvantage of being opaque, thus obscuring the original surface of the fossil. By using the synthetic resin known as 'Marco Resin S.B.26 C', the transparency of the plastic allows the original side of the specimen to be seen. Its adhesive powers are stated to be at least as good as those of rubber. Laboratory details of the process are given in the paper, the dentary of a Eugnathid fish from Purbeck limestone being selected as an example.

The Wandering Albatross

Although well known to sailors and others who make sea voyages, not many people have seen the wandering albatross in its breeding territory. There are few places which this great sea-bird, with a wing-span of about seventeen feet, finds suitable for nesting; in the southern oceans there are probably not more than six islands. Chief among them is Marion Island, one of the Prince Edward group, which is situated within the Roaring Forties. Its suitability as a breeding place for the wandering albatross is probably due to the weather, which is extreme enough to exclude human beings but not severe enough to endanger the life of the young birds in their growth to maturity. One human being who has observed the nest-building, egg-laying, incubation and other habits of the wandering albatross is J. A. Bennetts. His account is recorded in a recent issue of *Scottish Zoo and Wild Life* (3, No. 2; Jan. 1951); the article is accompanied by some photographs showing the immature chick and the courtship behaviour of adult birds.

Blundells' School Science Society

The fifth issue of the magazine of the Blundells' School Science Society is yet another example of the splendid work being done at many boarding schools in Great Britain in the training and inspiration of young scientific workers. In 1950, besides a series of general lectures to the Society ranging from the biology of the south-west Pacific to the production and measurement of high vacua, records were kept by individual boys to illustrate the local meteorology, entomology and ornithology. Five hundred birds were ringed by the Ornithological Section of the Society, while one group of bird-watchers spent a camping week-end recording the birds of the Ponchydown area. The Geographical Section toured South Devon to study physical formations in relation to land utilization, and a full account of their observations is presented. The magazine also contains prize-winning essays describing original inquiries made by boys. Those dealing with the reactions of nymphs of two species of may-flies to various ecological factors, variations in the sex ratio of the meadow brown butterfly and the investigation of double flower specimens of ladysmock are particularly noteworthy, as are a number of contributions by the teaching staff.

Smithsonian Institution: Annual Report for 1948–49

The annual report of the Board of Regents of the Smithsonian Institution for the year ended June 30, 1949 (see *Nature*, 165, 641; 1950), has now been issued bound with the General Appendix (Publication 3996; pp. 422+82 plates; Washington, D.C.: Government Printing Office, 1950; 2.75 dollars). This includes reports of investigations made by collaborators of the Institution, as well as some memoirs of a general character or on special topics that are of interest or value to the numerous correspondents of the Institution. Among these are Sir Harold Spencer Jones's Arthur Lecture on the determination of precise time, Prof. F. E. Zeuner's address to the Royal Institution on time in evolution. H. Friedman's paper on the "Breeding Habits of the Weaver-Birds: a Study in the Biology of Behaviour Patterns", E. H. Walker's article "New Zealand, a Botanist's Paradise", and A. V. Kidder's paper on the archæological importance of Guatemala. The rest of the papers have been previously published elsewhere, though some, such as those of E. Hubble on the 200-in. Hale telescope and some of the problems it may solve, and E. D. Walker on "Animal Behaviour", may not be easily accessible to British men of science.

Technical Information and Documents Unit

The Technical Information and Documents Unit, which for a number of years has been attached to the Board of Trade, has become a part of the Information Services of the Department of Scientific and Industrial Research. The Unit has a large collection of unpublished documents, which contains valuable information on the production and use of substitute materials, and these are at the disposal of industry in Great Britain. There is a small Technical Section for assistance in the selection of material to meet specific needs, and a reading room is provided for those wishing to make a detailed study of drawings and documents. Alternatively, photocopies can be supplied at moderate charges. The Unit is still at Lacon House, Theobalds Road, London, W.C.1.

Zoological Society of India: Officers

Officers of the Zoological Society of India have been elected as follows: *President*, Prof. K. N. Bhal, professor of zoology, University of Lucknow. *Vice-Presidents:* Dr. S. L. Hora, director, Zoological Survey of India, Calcutta; Dr. M. A. Moghe, principal, Amraoti College. *Secretary:* Dr. M. L. Roon-

wal, forest entomologist, Forest Research Institute, Dehra Dun. *Treasurer:* Dr. B. S. Chauhan, Zoological Survey of India, Calcutta. *Editor:* Dr. B. N. Chopra, fisheries development adviser, Government of India, New Delhi. *Members of Council:* Dr. H. S. Pruthi, plant protection adviser to the Government of India, Ministry of Agriculture, New Delhi; Dr. N. K. Panikkar, chief research officer, Central Marine Fisheries Research Station, Mandapam; Prof. A. B. Misra, professor of zoology, Banaras Hindu University; Prof. H. R. Mehra, professor of zoology, University of Allahabad; Prof. R. V. Seshaiya, professor of zoology, Annamalai University; Prof. Bhaskaran Nair, professor of zoology, University College, Trivandrum.

Information Bulletin of the U.S. National Academy of Sciences and National Research Council

THE United States National Academy of Sciences and the National Research Council are now issuing free of charge to all organizations and individuals directly associated with the Academy or the Research Council a new information bulletin, *News Report*, the first number of which (1, No. 1, January–February; pp. 20) illustrates the present concept of the scope of the new publication. It includes an article on the scientific man-power situation in the United States, by M. H. Trytten, director of the Office of Scientific Personnel, another by O. M. Ray describing the functions of the Committee on Growth, created in 1945 to advise the American Cancer Society on the support of scientific research in problems of malignant and normal growth, and another by R. W. Crum on the work of the Highway Research Board. Features such as "Science News", "Scientific Personnel" and "International Relations" record activities in different branches of science, openings such as Fulbright fellowships, trends in advanced training, and the activities of the international scientific unions. Besides the calendar of international congresses included in the last-named feature, there are a further schedule of meetings during the year of affiliated societies and a calendar of meetings of the Academy and the Research Council, with a list of their new publications. The annual subscription for those not receiving *News Report* automatically is 2 dollars, to be sent to the editorial office at 2101 Constitution Avenue, Washington 25, D.C.

University of London: Appointments

THE following appointments have been made in the University of London: Dr. D. R. Crofts, to the University readership in zoology tenable at King's College of Household and Social Science, from October 1; Dr. Werner Ehrenberg, to the University readership in physics tenable at Birkbeck College, from October 1.

"New Inhibitors of the First Stage of the Blood-clotting Process"

DR. E. HECHT, whose communication under this title appeared in *Nature* of February 17, p. 279, points out that it does not quite conform to the reprints which have been prepared: thus, for "Sphingosine has the same solubility properties as Tocantins's 'anticephalin'[3] but differs from the latter by being thermostable" read (as in reprint): "Sphingosine has the same solubility properties as Tocantins's 'anticephalin'[3], but the latter has been shown by partition chromatography to be a mixture of our non-protein activator, sphingomyelin and sphingosin". The following reference should also be added: Tocantins, L. M., and Carroll, R. T., "Blood Clotting and Allied Problems", edited by J. E. Flynn. New York (1949).

Announcements

DR. ILMO HELA, at present assistant professor of geophysics in the University of Helsinki and lecturer in meteorology in the Institute of Technology, University of Finland, has been appointed assistant professor of oceanography in the University of Miami Marine Laboratory. Dr. Hela will carry out research into problems connected with the Florida Current and other water-movements in the Gulf of Mexico and Caribbean Sea.

THE Textile Institute, at 16 St. Mary's Parsonage, Manchester, 3, is prepared to assist research conducted on cotton spinning, doubling and twisting, and is offering grants from the Frank Wright Memorial Fund to persons of British nationality. Further details can be obtained from the general secretary of the Institute.

THE Medical Research Council is offering a Kathleen Schlesinger fellowship for research on the origin and nature of cysts of the brain whether arising from tumours or not or for studies of other conditions of the central nervous system as the Council may permit. The fellowship is ordinarily tenable at the National Hospital for Diseases of the Nervous System, Queen Square, London, W.C.1, and is worth £700–1,000 a year for one year initially and renewable up to three years. Application forms, obtainable from the Secretary, Medical Research Council, 38 Old Queen Street, London, S.W.1, must be completed by May 31.

THE Development Commission announces that it is offering a few grants to British postgraduate honours students for training in research problems in marine or freshwater science, which is designed primarily to fit them for employment either in the fishery research services of the Ministry of Agriculture and Fisheries and the Scottish Home Department or in a marine or freshwater biological research institute. The grants are worth £220–300 a year with extra university fees paid, together with a marriage allowance, and are tenable initially for one year but renewable up to a maximum of three years. Application forms, to be returned by June 1, can be obtained from the Secretary, Development Commission, 6a Dean's Yard, Westminster, London, S.W.1.

THE Department of Inorganic and Physical Chemistry of the University of Leeds is arranging a postgraduate summer school on "Optical Crystallographic Methods", to be held in Leeds during September 3–14, which will be similar to those organized at University College, Swansea, in 1946 and 1947. The course will provide basic training in the theory and use of the polarizing microscope in the study of crystals and other birefringent materials, and in the applications of the instrument in other branches of science and technology. Fees for the course are 15 guineas for tuition and 9 guineas for accommodation. Enrolment forms, obtainable from Miss M. Spink, Assistant to the Director of Extra-Mural Studies, University, Leeds, 2, must be completed by May 11.

ERRATUM. In the communication "Antitumourigenic Action of Steroids . . ." by Prof. A. Lipschutz *et al.* in *Nature*, February 10, on p. 236, col. 1, par. 3, line 2, for "4 μgm." read "42 μgm.".

NEUTRON-INDUCED ISOMERS OF XENON: A NEW ISOMER OF XENON-129

By INGMAR BERGSTRÖM
Nobel Institute of Physics, Stockholm

ACCORDING to nuclear shell theories, xenon should have isomers for each odd mass number equal to, or less than, 135. Xenon-127 and -135 show isomerism according to Seaborg's tables; xenon-131 [1] and xenon-133 [2] have recently been shown to have isomeric states. The failure to observe the metastable xenon-129 could be due to a short half-life, soft conversion electrons or to its having nearly the same half-life and energy as another isomer of xenon.

In order to search for the metastable xenon-129, xenon was irradiated in the Bepo at Harwell. After irradiation the xenon activities were electromagnetically separated at this Institute. The β-activity as a function of the position on the aluminium collector foil is shown in Fig. 1. As can be seen from the graph, all odd mass numbers show β-activity except 135 and 125, the half-lives of which are too short to be observed. The collector foil was cut into strips according to the activity spectrum of Fig. 1. Each mass number was separately investigated with the β-spectrometer. In this way we have obtained the following preliminary results for the long-lived xenon isomers produced by pile neutrons.

Xenon-127. Fig. 2 shows the β-spectrum of xenon-127, the half-life of which is about 30 days. Electron lines of the following energies were found: 22·8, 26·8, 51·8, 112, 137, 166 and 196 keV. The first two lines have energies in agreement with the Auger lines K–$2L$ and K–L–M of iodine, which would mean that the long-lived xenon-127 decays mainly by K-capture to iodine-127, since no positive or negative β-particles were observed.

The weak 51·8-keV. line is interpreted as an L-line of a γ-ray of the energy 57 keV. The corresponding K-line would then have the energy 23·8 keV. and cannot be resolved from the first Auger line. The intensity ratio of the first two Auger lines has been measured for xenon and cæsium, and this ratio was about 2·0 in both cases. For the Auger lines found in the decay of xenon-127, this value was 3·0, indicating that about 0·3 of the intensity of the 22·8-keV. line should be due to a conversion line.

The intensities and energies of the lines at 166 and 196 keV. are consistent with the K- and L-lines of a γ-ray of energy 200 keV. The conversion lines at 112 and 137 keV. are most probably K-lines. γ-Rays of the energies 57, 145, 170 and 200 keV. are then associated with levels in iodine-127. The sum of the energies of the first two γ-rays is equal to that of the fourth one within the limit of error. The position of the third level from which the 170-keV. γ-ray is emitted cannot be given unambiguously from $\overline{ee}$-coincidence results in the β-spectrometer, due to reasons of intensity. (*Note added in proof.* Using a sodium iodide scintillation spectrometer, a γ-ray of the energy 365 keV. was later found. It should be noticed that the sum of the energies of the 170 and 200 keV. γ-rays is equal to the energy of the 365 keV. γ-ray.)

Both activities belonging to xenon-127 have been investigated by Creutz *et al.*[3], who in the longer activity report two electron groups with the range 35 and 350 mgm. Al/cm.². The first group is consistent with our measurement; but the second group (corresponding to a γ-energy of about 900 keV.) might be due to contamination, since it is not found in our separated sample. Creutz *et al.* have suggested that the 75-s. activity is responsible for the isomeric transition. Our measurements indicate that the 30-d. activity is associated with the decay of the ground-state of xenon-127. This isomer would be an exception to predictions based on the nuclear shell model of M. G. Mayer, which has been pointed out recently by P. Axel[4].

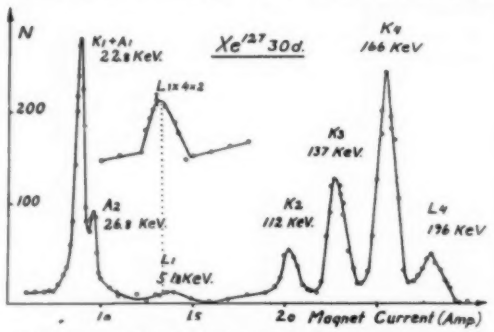

Fig. 2. Conversion lines of electromagnetically separated xenon-127

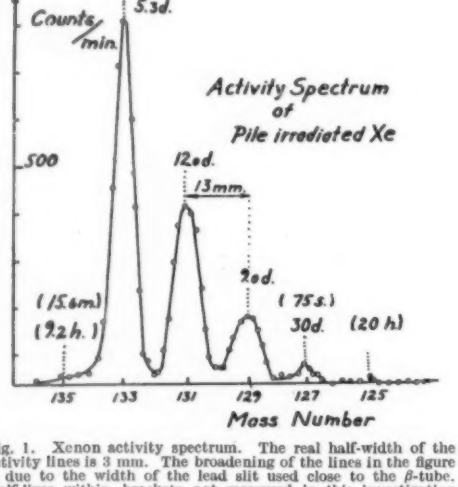

Fig. 1. Xenon activity spectrum. The real half-width of the activity lines is 3 mm. The broadening of the lines in the figure is due to the width of the lead slit used close to the β-tube. Half-lives within brackets not measured in this investigation

Xenon-129. A new xenon activity of mass number 129 has been discovered. The half-life is 8·0 ± 0·2 days and the γ-energy of the isomeric transition 196 ± 2 keV. The intensity ratio of the K and $L + M$ conversion electrons is about 2·1. The half-life and the energy make the multipole order 5 probable. Nuclear shell theory predicts the spin

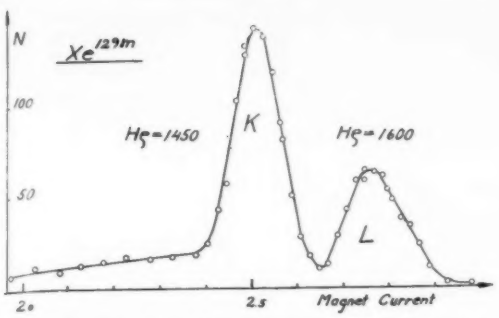

Fig. 3. Conversion lines of electromagnetically separated xenon-129

11/2 for the isomeric state. The spin of the ground-state of xenon-129 is 1/2. The radiation would then be electric. As the spin of the stable xenon-131 is 3/2, the isomeric transition would in this case correspond to a mixture of electric and magnetic radiation, provided the isomeric state has the spin 11/2. It is then surprising that $N_K/(N_L+N_M)$ for xenon-129 and -131 are so close (~2·1 and ~1·9 respectively). This similarity can be explained if the spin of the isomeric state of xenon-129 is 9/2, which, however, would be an exception to the predictions of the $J-J$ shell theory.

As no other conversion lines were found in the xenon-129 sample, it is possible that the isomeric state is the lowest excited level in xenon-129. The β-transition $^{129}\text{I} \rightarrow {}^{129}\text{Xe}$ would then occur between the ground-states. Because of the low β-energy, 120 keV.[5], and the spin difference 7/2–1/2[5], the $f \cdot t$-value for the β-transition would be very high, in agreement with the long half-life of iodine-129[5].

Xenon-131. The K- and L-conversion lines of an isomeric γ-transition with an energy of 163 keV. have been observed:

$$\frac{N_K}{N_L + N_M} = 1 \cdot 9.$$

Thus the xenon isomer produced in the decay of iodine-131[1] is identical with the neutron-produced activity.

Xenon-133. In addition to a β-continuum and the strong conversion lines of an 81-keV. γ-ray, we have observed the weak conversion lines of a 232-keV. γ-ray, which has recently been reported by us[2] as being associated with an isomeric transition in xenon-133. The resolving power of the β-spectrometer was 1 per cent in this measurement and about 5 per cent in the other cases. As

$$\frac{N_K}{N_L + N_M} = 2 \cdot 3,$$

an isomeric transition associated with xenon-133 seems to be well established.

Further communications dealing with these problems will appear in *Arkiv för Fysik*.

We wish to express our thanks to the Isotopic Division at Harwell for their excellent service and their interest in the rare-gas irradiations.

[Dec. 11.

[1] Brosi, A. R., De Witt, T. W., and Zelders, H., *Phys. Rev.*, **76**, 94 (1949). Bergström, I., *Phys. Rev.* (Oct. 1, 1950).
[2] Bergström, I., and Thulin, S., *Phys. Rev.*, **79**, 537 (1950).
[3] Creutz, E. C., *et al.*, *Phys. Rev.*, **58**, 481 (1940).
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[5] "Nuclear Data", National Bureau of Standards, Circ. 499, 150 (1950).

A LONG-PERIOD CHANGE IN RADIO-FREQUENCY RADIATION FROM THE 'QUIET' SUN AT DECIMETRE WAVE-LENGTHS

By W. N. CHRISTIANSEN and J. V. HINDMAN

Division of Radiophysics, Commonwealth Scientific and Industrial Research Organization, Australia

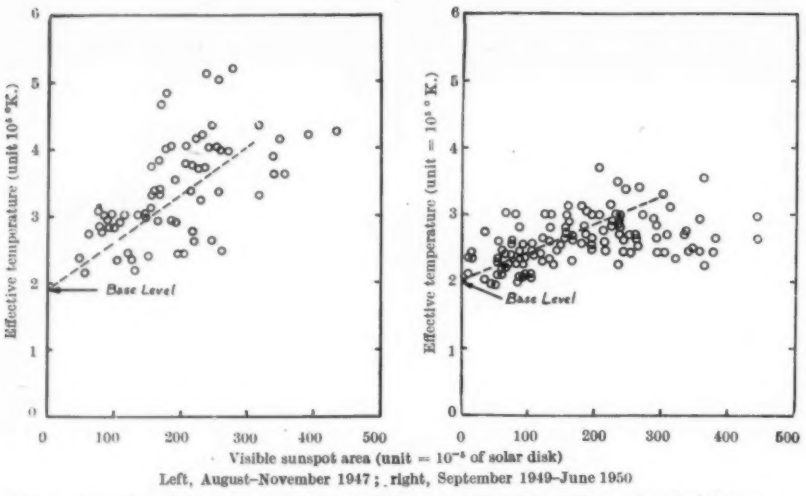
At decimetre and centimetre wave-lengths, the radiation flux from the sun changes from day to day in a manner related to the daily change in sunspot area[1,2] or number. Pawsey and Yabsley[3] found that this radiation could be divided into two components, one of which was correlated with the visible sunspot area, and the other identified with thermal radiation from the quiet sun[4–7]. They pointed out that some observations then available suggested a change in the latter component during the sunspot cycle, but that more observations were required before this could be established. Such a change was predicted by van der Hulst[8], on the basis of an observed decrease in the electron density of the corona towards the minimum of the sunspot cycle.

At this laboratory, observations of solar radiation have been made over a large part of the period since 1947 on wave-lengths of 50 and 25 cm., and since 1948 on 10 and 3 cm. Results of measurements on 10·7 cm. made by Covington[9] during the period 1947–49 are also available. The records have been examined to see if the effective temperature of the quiet sun is changing in the period since the maximum phase of the solar sunspot cycle.

Year \ Freq.	Percentage increase over base temperature per hundred units sunspot area			
	50 cm.	25 cm.	10 cm.	3 cm.
1947	25	35	38	5
1949–50	12	20	18	5

Unit of sunspot area = 10^{-6} of the solar disk.

In Fig. 1 the daily value of the effective solar temperature at a wave-length of 25 cm. is plotted against visible sunspot area for two periods: the first from August to November 1947, when the average sunspot area was approximately 210×10^{-6} of the disk area, and the second from September 1949 to June 1950, when the average sunspot area was 160×10^{-6}. The dotted lines indicate the average temperature for a given value of sunspot area, and when extrapolated to zero sunspot area[3] give the 'quiet sun' or 'base' temperatures. It is seen that, although there was a significant reduction in the slope of the line of best fit relating effective solar temperature to sunspot area, the base temperature did not change appreciably in the two-year interval between the two sets of measurements. A similar change of slope without change of base-level was observed on a wave-length of 50 cm. Covington, on the other hand, reported to the 1950 Conference of the Union Radio-Scientifique Internationale that his 10·7-cm. records show a gradual fall in effective solar temperature of about 20 per cent between 1947 and 1949.



Left, August–November 1947; right, September 1949–June 1950

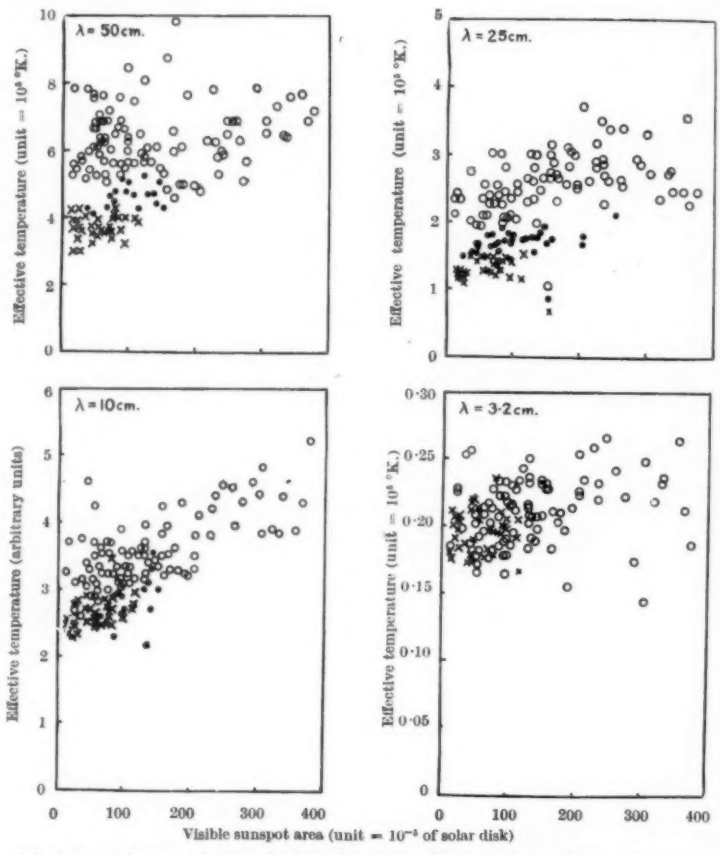
Fig. 1. Comparison of effects of sunspots on effective solar temperature during 1947 and 1949–50 at a wave-length of 25 cm.

In 1950, however, a marked drop in the base-temperatures was observed on wave-lengths of 10, 25 and 50 cm., commencing in July on 25 cm. and in August on 10 and 50 cm. This is illustrated in Fig. 2, which is similar to Fig. 1 but shows the results of observations on 3, 10, 25 and 50 cm., with recent observations indicated distinctively. On 25 cm., all but one of the daily readings of effective temperature during July–September fell below all previous ones for 1950, despite the inclusion in the latter of many cases of smaller sunspot area. At a wave-length of 3 cm. no change greater than the uncertainty of observations was found. Similarly, at the longer wave-length of 150 cm., Dr. C. W. Allen has informed us that he has detected no change greater than the experimental uncertainty of 10 per cent.

The observed decreases on wave-lengths of 3, 10, 25, 50 and 150 cm. are 0, 20, 45, 35 and 0 per cent, so that the effect appears to be confined to the decimetre wave-lengths. This is consistent with a decrease in coronal electron density, as suggested by van der Hulst.

The observations given here appear to establish that the base-level of the effective solar temperature is subject to long-term variations. It is proposed to investigate the relation between these changes and the solar cycle when observations have been carried out over a sufficiently long period.

We wish to acknowledge the help of Dr. J. L. Pawsey and Messrs. H. C. Minnett and D. E. Yabsley, who have been associated with the work, and Messrs. G. Fairweather.


λ = 50cm.
λ = 25cm.
λ = 10cm.
λ = 3·2cm.
Effective temperature (unit = 10⁵ °K.)
Effective temperature (arbitrary units)
Visible sunspot area (unit = 10⁻⁶ of solar disk)

Left, top and bottom: O—O—, January–July 1950; ●—●—, August 1950; ×—×—, September–October 1950. Top right: O—O—, January–June 1950; ●—●—, July–August 1950; ×—×—, September–October 1950. Bottom right: O—O—, January–August 1950; ×—×—, September–October 1950

Fig. 2. Scatter diagrams of effective solar temperature during 1950, showing drop in base-temperatures at decimetre wave-lengths in the later months

A. J. Harragon and G. H. Trensky, who made many of the observations.

[1] Covington, A. E., *Proc. Inst. Rad. Eng.*, **36**, 454 (1948).
[2] Lehany, F. J., and Yabsley, D. E., *Aust. J. Sci. Res.*, (A), **2**, 48 (1949).
[3] Pawsey, J. L., and Yabsley, D. E., *Aust. J. Sci. Res.*, (A), **2**, 198 (1949).
[4] Pawsey, J. L., *Nature*, **158**, 633 (1946).
[5] Martyn, D. F., *Proc. Roy. Soc.*, A, **193**, 44 (1948).
[6] Waldmeier, M., and Müller, H., *Astron. Mitt. Zürich*, No. 155 (1948).
[7] Smerd, S. F., *Aust. J. Sci. Res.*, (A), **3**, 34 (1950).
[8] van der Hulst, F. C., *Nature*, **163**, 24 (1949).
[9] Covington, A. E., Report ERB—242 NRC Canada (April 1950).

GOVERNMENT AID FOR THE SOCIAL SCIENCES

TWO recent issues of *Planning* are broadsheets on "Government Aid for the Social Sciences"*, in which Political and Economic Planning has reviewed some of the developments in this field since the end of the War. The success with which some of the techniques developed in the social sciences were used during the War, the increasing emphasis on social change, the special need in Great Britain for achieving a greatly improved rate of productivity and the realization that this depends to no small extent on improved human relations have all persuaded the Government to make increased provision for the needs of the social sciences. The first broadsheet examines the position in the universities, while the second reviews what has been done under the Research Councils, by the Departments of State and as regards the human factor in industry.

The stimulus came largely as a result of the recommendations of the Clapham Committee on the Provision for Social and Economic Research, which, however, as regards finance, confined its recommendations to the universities. *Planning* considers that the support that has been forthcoming in the past three or four years has, on the whole, been generous, and that it is no fault of the Government if, in terms of endowment and prestige, the social sciences are still the poor relations of the natural sciences. While the full effect of the increased provision cannot yet be judged, the broadsheets suggest that a critical point is now being reached and that important matters are coming up for decision which will determine the future of the social sciences for many years to come.

Taking as a guide the Clapham Committee's interpretation of its field as including economics and economic history, sociology, social anthropology and social psychology, political science, demography, economic and social statistics, and certain branches of medical statistics and law, *Planning* estimates that university expenditure on the social sciences in 1948–49 was £397,008, or 4·2 per cent of the total, as against £115,909 or 3·0 per cent in 1938–39. The university staff has increased from 291 in 1937–38 to 604 in 1949–50, and in 1948–49 1,057 honours degrees were awarded, or 10·2 per cent of those awarded in all subjects, as against 335 or 6·4 per cent in 1938–39. Most of the money has gone to increase the teaching staffs, and here, particularly in sociology and related subjects, expansion has been limited by the scarcity of well-qualified people. Some further expansion of staff still seems to be needed, and the distribution over the different subjects is still uneven.

The first question for decision is whether the earmarked grants for the social sciences should continue in the next quinquennium or whether they should be merged in the general or block grants made by the University Grants Committee to universities. *Planning* clearly does not consider that a reasonably satisfactory level of development has yet been reached in the social sciences for the earmarked grants to be discontinued so early. The social science faculties in each university would thereby be involved in a struggle with other faculties over the distribution of the money, in which their early stage of development might be a serious handicap and in which it might be difficult for them to obtain even the same money as before.

Attention is also directed to a further reason for giving special treatment to the social sciences. So far, the amount of new research which could fairly be attributed to the earmarked grant is comparatively small, chiefly because the universities have rightly in this phase concentrated on training the social scientists of to-morrow. This is in accordance with the priority generally recommended in the report on scientific man-power. The purposes of the Clapham Committee will not be fulfilled, however, unless more research opportunities are created, and the problem in the next quinquennium is likely to be one of finding research jobs for some of the abler students who are now being produced in greater numbers.

The universities still depend mainly on the great charitable foundations for research in this field, the Rockefeller and Nuffield Foundations alone providing £296,000 over periods of from two to ten years, and the Clapham Committee has urged that more money should be provided from official sources on a permanent and routine basis. *Planning* hopes that the universities will also seriously consider whether, if funds are insufficient to develop every side of the work, emphasis should not, during the next phase, be put on research into one of the less well-established disciplines of sociology, social anthropology and social psychology.

What matters most to the social scientist is the number of opportunities which exist for research and the use which is made of his special skill and experience and also of the results of his work. This makes necessary a review of the activities of the various Government bodies and other institutions by which the grants are made. The extent of these activities is illustrated, rather than comprehensively described, in the second broadsheet.

While the main work of the Medical Research Council falls outside the province of the social sciences, work on some aspects of physiology and psychology, especially in the fields of industrial and occupational health, provides some of the basic material about human behaviour for the social scientist. Besides the Applied Psychology Unit at Cambridge, there are the Group for Research in Industrial Psychology, the Occupational Psychiatry Unit at the Maudsley Hospital, the Social Medicine Research Unit at the Central Middlesex Hospital and the Statistical Research Unit at the London School of Hygiene and Tropical Medicine. The Department of Scientific and Industrial Research has recently begun to show a direct interest in the social sciences arising out of the 'operational research' approach to industrial problems and the encouragement given to research associations to make detailed productivity

* Government Aid for the Social Sciences. (Political and Economic Planning, 16 Queen Anne's Gate, London, S.W.1.)

studies. The Advisory Council has expressed the opinion that the research associations should be free to undertake investigations, including economic and sociological studies, in any field of science, and considers that the linking of physical science and engineering with economic studies within industry holds much promise for the future. The Development Commission is also able to make grants from the Development Fund for investigations and surveys of special rural problems and has already made grants for surveys of small-scale industries in country towns in various regions.

From the Colonial Development and Welfare Funds some £776,000 has been available for social science and economic research, and a Colonial Social Science Research Council has been set up to administer grants for such purposes. The Council has already established three research institutes—in the West Indies, and in East and West Africa—while the work of the existing Rhodes-Livingstone Institute in Central Africa has been expanded by a grant of £100,000 over five years. Research into economic problems affecting the Colonies is supervised and supported by the Colonial Economic Research Committee. With minor exceptions the Departments of State dealing with economic and social affairs have taken little direct interest in research in this field, although some, like the Home Office and the Ministry of Health, have specific powers under recent Acts to commission or make grants for research. The recent report of the Committee on Qualifications of Planners stressed the need for the social sciences to contribute to the work of the Ministry of Town and Country Planning; but the activities of the very few research officers of the Ministry are neither properly co-ordinated nor, for the most part, concerned with any but short-term questions. The Ministry of Education carries out no research but has made grants of more than £20,000 since the end of the War to the National Foundation for Education and Research, which, however, is left free to plan its own research and has an income of £8,000–9,000 a year, chiefly from corporate subscriptions.

Of the work of the so-called 'economic' Departments, including under this head the General Register Office, the broadsheet remarks that the immense amount of work of interest to the social scientist is handled by the Departments concerned rather as technical processes than as research jobs. One particular project mentioned is the study of industrial location which, in 1948, the Industrial Location Division of the Board of Trade invited the National Institute of Economic and Social Research to undertake. There are also the various Commissions, such as the Monopolies Commission and the Royal Commissions on Population and on the Press, which have instituted extensive inquiries, and the Government Social Survey, which was established in 1946 as a permanent part of the machinery of government, is also participating in the wider research field. The Committee on Industrial Productivity, set up in December 1947, was given a Panel on Human Factors affecting Productivity; and, although the parent Committee has now been dissolved, the work of the Panel is being continued, divided between the Medical Research Council and the Department of Scientific and Industrial Research.

The general conclusion reached by *Planning* in these broadsheets is that the work being carried on in the social sciences has so far been more impressive in scale than in quality. Some concern is expressed that the expansion of the teaching facilities in the social sciences at the universities will not of itself attract a sufficient proportion of the best undergraduate material or provide adequate research opportunities for the newly trained people. There are also many social and economic problems which still await systematic investigation. The independent research institutes have also an essential contribution to make to the advancement of research in the social sciences, particularly on more 'applied' problems and where team-work by people trained in different disciplines is required. The administration of funds in support of such institutes would be more conveniently conducted by a Social Science Research Council, and Political and Economic Planning suggests that the establishment of such a Council should be reconsidered in the light of a full and critical examination of the work and needs of these research institutes. Finally, the broadsheet welcomes the decision of a representative group of social scientists to establish a new professional association to bring together all those who are interested in the scientific study of society and to undertake the various functions appropriate to an organization with this object. Such a body should have an excellent opportunity of raising the standards and the prestige of the particular social sciences with which it will be concerned.

FUTURE OF THE OVERSEAS FOOD CORPORATION

SINCE the second annual report of the Overseas Food Corporation was issued last autumn, both the Corporation and the Government have accepted, in their main essentials, the recommendations in the report of the Kongwa Working Party for restriction of cultivation over the next three years to about 12,000 acres. These recommendations were also taken into account by the Corporation in preparing a revised long-term plan for the East African Groundnut Scheme. This plan has now been issued as an appendix to a White Paper on the Future of the Overseas Food Corporation* in which the Government announces its decision to write off the £36 millions already expended on the scheme and to transfer to the Colonial Office the responsibility for the revised plan which is now regarded as a scheme of large-scale experimental development to establish the economics of clearing and mechanized, or partly mechanized, agriculture under tropical conditions. Even on the modified basis now proposed, the scheme cannot fail to be an important contribution to the economic development of Tanganyika, and the results of the experiments being undertaken may be of value in many other tropical territories.

The Corporation's new proposals cover a period of seven years up to 1957. They envisage no further land-clearing at Kongwa or Urambo after the end of 1950. Of the 90,000 acres cleared at Kongwa, about 24,000 acres are to be set aside for agriculture, of which 12,000 will be under crop each year, the remainder of the cleared land being available for grazing. The object is to conduct fully costed field-scale trials on a limited acreage for three years, when a further review will be made, in the light of the

* Overseas Food Corporation. The Future of the Overseas Food Corporation. (Cmd. 8125.) Pp. 20. (London: H.M. Stationery Office, 1951.) 9*d*. net.

results achieved, of the possibility of again extending arable agriculture over some or all of the remainder of the cleared land. It is not expected that more than 45,000 out of the 65,000 acres cleared at Urambo will be available for agriculture for the harvest of 1951; but 60,000 acres will be ready later. Of the 20,000 acres felled in the Southern Province, 7,000 acres will be available for agriculture for the 1951 harvest, and during the current wet season a further 40,000 acres are being felled with the two land-clearing teams built up for that purpose. Thereafter, the Corporation proposes drastically to reduce the tractor force to the minimum required to complete the remaining operations on this 40,000 acres and to adopt a slower and cheaper method of land clearing involving the substitution of hand labour for part of the work at present done by machines. Under this scheme the same tractor force might be expected to fell an additional 15,000 acres of land per year, and the Corporation contemplates that the same acreage would be brought into cultivation each year, giving by 1957 a total of 105,000 acres fully cleared for agriculture and a further 35,000–45,000 acres in various stages of preparation. In this revised scheme all three areas, with one exception at Kongwa, will be farmed in units of 1,500–6,000 acres, under intensive supervision by men who can gain an intimate knowledge of the land which they farm, instead of the 30,000-acre units originally proposed. The Corporation stresses the need for continuity of agricultural operations over a period of at least seven years in the interests both of efficiency and of the morale of the staff which, it is now admitted, has suffered from past uncertainties and changes of plan.

The Government is satisfied that some assurance of continuity is reasonable and indicates its firm intention, provided the costs do not greatly exceed the estimates, that funds should be provided to enable farming operations to continue for seven years. It approves the proposal for a review in 1954 before deciding on what scale further felling and clearing should be undertaken. It is estimated that over this seven-year period a further £6 million will be required, without allowing for any contingencies or for any bush clearing after 1954. While the Corporation does not consider that on the basis of the new plan its needs alone would justify the completion of the new part of Mtwara, in the light of decisions by the Tanganyika Government and the East African Railways and Harbours Administration to construct and improve feeder roads and to extend the railway sixty miles westward from the groundnut area, the Corporation has agreed, with the concurrence of the Government, to complete the port and the railway connecting it with the existing line.

The conclusions on which this revised plan is based are clearly stated in the appendix. First, the attempt to produce crops economically on land which has been cleared for agriculture at a great cost in money and human effort must be sustained for a sufficiently long period—put at a minimum of seven years—to show conclusive results. Second, the areas selected for development are capable of giving good yields of groundnuts and have done so on the small experimental farms. The problem yet to be solved is that of reproducing something approaching these results on a large scale. It is now concluded that the groundnut is not a plant which lends itself readily to mass methods over vast acreages, and that the attainment of economic yields demands intensive farming. Third, the clearing of forest and bush by wholly mechanical means from land of the type occupied by the Corporation has proved impracticable within either the time or the cost envisaged in earlier plans; it cannot be done at an economic cost in relation to the value of the arable land created. Fourth, the Corporation considers that it would be wasteful not to utilize, at least for a maximum tree-felling effort (the most efficient and economical of the mechanized operations) during the coming wet season, the accumulated resources in communications, installations, machines and man-power which have been built up over the past three years. Finally, provision must also be made from the capital remaining at the disposal of the Corporation to cover commitments, mainly worthless, from the past and for some reserve against unforeseen contingencies in the execution of any revised plan.

The plan formulated is accordingly designed to establish, by agricultural practices and scientific experiments, a pattern of agriculture which will utilize economically all the cleared land available and which, if successful, will point the way to future development; to equip all the cleared land with permanent installations and adequate machinery and implements, without which the capital expenditure on land clearing will be wasted; and to establish that sense of permanence and stability without which no constructive objective can be achieved efficiently. The plan should also execute in the Southern Province the first stage, extending to 1957, of what may become, as a result of a later review of the economic prospects, a scheme to develop the total area capable of being serviced from Nachingwea, utilizing the installations, machinery and man-power already accumulated.

The revised plan thus appears to offer reasonable prospects of turning to the best account the resources already engaged and the experience gained. The technical and research aspect may possibly be overstressed, for the proposals scarcely bring out the importance of one lesson taught by the failure of the larger scheme, namely, the necessity of training the indigenous people in modern agricultural methods if balanced progress in development is to be achieved. Stress is rightly laid on the importance of morale and the necessity for reasonable compensation for the thousand or so European staff who will become redundant during the next three years; but something could well have been said of the part that Africans are to play in the scheme, for its ultimate success must also depend on the transformation of inexperienced Africans into successful farmers able and willing to reclaim and maintain their own land.

CENTRAL DRUG RESEARCH INSTITUTE, INDIA

THE Council of Scientific and Industrial Research, India, launched six of its national laboratories during 1950. It has planned eleven such institutions so far, and the remaining five its energetic director, Sir Shanti Swarup Bhatnagar, expects to launch in the course of 1951. The seventh of the series, dedicated to research on drugs, was the occasion of an impressive inaugural ceremony in a very picturesque setting in a Lucknow palace on the bank of the Gomati on February 17.

The imperative need for a Central Drug Research Institute was stressed in 1947 by the Pharmaceutical and Drugs Committee of the Council, and an outline scheme for such a body was drawn up by Dr. B. Mukerji. A planning committee came into being early in the following year, and a few months later the assistant director (planning) was appointed. After examining various suggested locations, the Committee decided on Lucknow, as it is a university town with a medical college and a first-rate teaching hospital; the Government of the State offered the historic Chattar Manzil Palace as a free gift to the Council to house the proposed Drug Research Institute.

Lucknow is proud of its many eighteenth- and nineteenth-century buildings, and of having evolved an architectural style of its own, ornate and tortuous, and often seeking to combine Mughal and Western elements. Chattar Manzil ranks high in Lucknow architecture. An army engineer, Claude Martin, built part of the Manzil; but it was later acquired and extended by successive Nawabs of Oudh. The British converted the Nawabs' harem into a club, and now renascent India is transforming it into a modern research centre. The architect and engineers of the U.P. Government and the assistant director (planning) have had a difficult task in effecting this metamorphosis. For the present, only a portion of the four-storied palace has been converted; but this covers quite 25,000 sq. ft. Certain other portions cannot be adapted without considerable expense. The alterations, including gas and water installation and fresh electric wiring, have cost about Rs. 7 lakhs. A new building would no doubt have cost about seven times this amount. When extensions become necessary, these will be planned in architectural harmony with the Lucknow-style palace. For the present, the only altogether new additions to the buildings are the gas house and the animal house. The animal house when completed and equipped will have cost about Rs. 2½ lakhs. Four of its rooms will be air-conditioned—showing, Sir Shanti humorously remarked, tender consideration for animals, for in the main laboratory only the director's room is being air-conditioned. A nucleus for a workshop has already been set up in one of the outhouses; but in the near future a more suitable workshop will have to be built.

The Institute will promote drug research, test and standardize drugs discovered by the Institute, provide expert advice for their further development and production, offer research facilities and advice to scientific workers, universities and industry, organize controlled clinical trials of drugs in clinics, and disseminate scientific knowledge relating to drugs.

To begin with, the Institute has five divisions: (1) chemistry, (2) biochemistry, (3) pharmacology, (4) microbiology and parasitology, and (5) clinical science. A sixth division (botany, including pharmacognosy) is proposed for the near future. In addition to these scientific divisions, the Institute has an animal house, an intelligence and statistical section including a central library, a museum, the necessary administrative sections and a cafeteria. A first-rate herbarium would be necessary for the pharmacognosy division.

The inauguration ceremony, presided over by the Governor of the United Provinces, Sir H. P. Mody, opened with a speech by the Hon. Mr. Sri Prakasa, Minister for Natural Resources and Scientific Research, who referred to India's creditable contribution to ancient medicine, narrating the mythological origin of the science with the birth of Dhanvantri, physician of the gods, who brought with him the 'Three Bitters' and 'Three Astringents'—the simples out of which a pharmacopœia grew. The Premier and the Health Minister of the United Provinces (the latter is also chairman of the local committee for the Institute) referred to the importance of the drug industry in India's national economy and to the plentiful sources of drugs in India and more particularly in the United Provinces. The Hon. Rajkumari Amrit Kaur, Minister for Public Health, also stressed the importance of the drug industry and India's contribution to early medicine. Sir Shanti Bhatnagar said that the Institute would have to be a blending place of old and new knowledge: "It will be one of the essential functions of this Institute to subject remedies used by *vaids* and *hakims* to trial and if investigations prove them to be really effective to propagate their use to save the world from misery and disease".

Pandit Nehru, in declaring the Institute open, said that he attaches great importance to research on drugs; but he has no sympathy with the "valetudinarian outlook on life", and he ridiculed the polite conversation which suggests that being healthy and robust is vulgar; he remarked that in his youth he had been fascinated by Samuel Butler's satire and the wholesome Erewhonian practice of sending criminals to hospital for treatment while awarding a term in prison to invalids. Pandit Nehru paid a tribute to the devotion and industry of those entrusted with the hard work of the initial stages of the Institute, and said that it had been lucky in having had the benefit of Sir Edward Mellanby's guidance, even though he had only been available as director for about three months. He announced that Sir Edward would be succeeded by Dr. B. Mukerjee, director of the Drug Institute in Calcutta.

The Institute has had the advantage of guidance from Colonel R. N. Chopra, to whose pioneer work on drug research tributes were paid by Sir Shanti Bhatnagar as well as by Sir Edward Mellanby. Colonel Chopra was present at the inauguration and said: "This is a great day for drug research in India". He complained that the cost of essential drugs has recently been mounting higher and higher, whereas the masses in India are "too poor to obtain treatment for minor ailments, to say nothing of specific remedies required to fight disease. The majority of these are of foreign origin and their cost is prohibitive because commercial firms abroad have spent enormous sums of money on their development." Drug research in India hitherto has been sporadic, unorganized and haphazard; the Institute would put it on a sound, systematic and permanent basis. Thanks to its varied climatic, meteorological and topographical features, India, Colonel Chopra pointed out, has one of the richest floras in the world. "Plants containing medicinal principles grow abundantly and about 2,000 of 11,000 species found in India are enumerated in the indigenous medicine." Even work on plant chemistry has largely confined itself to alkaloids, glucosides and essential oils. An enormous field, yet unexplored, is open to investigators if plant research receives a new orientation in the new Institute and plant antibiotics are also studied. Recent work in India has shown the presence of substances of antibiotic nature, active against pathogenic bacteria, in common Indian plants. Collaboration between chemists, pharmacologists, botanists and micro-

biologists in the new Institute is full of possibilities not only of scientific and academic interest but also of great practical economic importance to India.

Sir Edward Mellanby emphasized that, for a nation's health, drugs can at best form the second line of defence; the first line must always be the public health services. He referred to ancient India's contribution to the foundation of medicine, especially in the treatment of disease by plant products. It is a paradox, he said, that "whereas a large part of the plants, from which official drugs in the pharmacopœia are made, are already grown in this country, yet many of these drugs are imported in large quantities".

METHODS OF LABOUR STATISTICS USED BY LONDON TRANSPORT

IN a paper submitted to the Institute of Actuaries and entitled "Personnel Statistics and Sickness Absence Statistics", Messrs. F. H. Spratling and F. J. Lloyd, of the London Transport Executive, discuss the importance of a systematic collection of data on numbers of staff, wastage and sickness absence in a large organization. Simple enumerations of the numbers employed as well as turnover and sickness absence rates, they argue, do not form a sufficient basis for the development of a successful staff policy. Policy should be based on a study of the age and length-of-service distribution of the population, which makes it possible to estimate the numbers of skilled and experienced staff that will be required and to calculate the financial cost of pensions and sick pay.

To meet the requirements of administrative, financial and medical planning, London Transport, which employs a hundred thousand people, has developed specialized methods of collecting and analysing personnel statistics. The information, obtained from the employees' personal record files at the various employing departments, is collected and recorded in a Central Record of Staff Statistics which consists of three files of punched cards. The Main File gives up-to-date details for each member of the active staff. A duplicate copy, made on December 31 of each year, is used to work out the age and length-of-service distribution of the population, and appears to be a useful device for adoption in personnel departments. The Wastage File consists of cards providing information for all leavers. The Sickness Absence File consists of cards for each spell of sickness absence; this differs from systems employed elsewhere, which collect on to one card all the absences of an individual employee.

Wastage is usually measured by the labour turnover rate, which expresses the annual number of leavers as a percentage of the average number employed during the year. This rate shows similar shortcomings to the crude death-rate, which ignores demographic factors such as the age-distribution of the population, and is not suitable for comparing experiences of different populations. In vital statistics it is therefore customary to calculate age-specific mortality rates. Similar techniques can be applied to turnover statistics, and the authors describe in detail a method of calculating specific rates which refer the number of leavers in a special age and length-of-service category to the number employed in that category. A method for making adjustments for irregular rates of recruitment is also discussed. The problem of calculating specific rates for very short periods is complex, and an alternative approach is the statistical analysis of the behaviour of new entrants in a given period of time.

Just as age-specific mortality rates are used for the construction of life-tables, so specific wastage rates can be used for constructing service-tables, and for estimating the trend of the working population. This represents an advance over the ordinary turnover rates which cannot be used for making accurate forecasts of staff changes. It is hoped that the specific wastage rates will prove a more reliable guide for estimating future employment requirements.

In the section on sickness absence, Mr. Spratling and Mr. Lloyd discuss the difficulties of collecting comparable sickness absence statistics. Absence rates are known to vary with the period for which sick employees are kept on the books. The authors advocate six months as a reasonable period. Other research workers consider a period of one month more suitable, and suggest that prolonged absentees should be kept on a special register, and excluded from the ordinary sickness returns. The authors recommend that separate records should be kept of short absences lasting less than four calendar days, and of long absences lasting four or more calendar days. This does not follow the line adopted by other organizations, which divide sickness into certified and uncertified sickness, where certified sickness may be less than four days, and the statistics are based on working days lost, not calendar days.

Mr. Spratling and Mr. Lloyd distinguish three absence-rate functions: the attack rate, which shows the average annual number of absences per worker; the average length of sickness absence during the year; and the sickness absence rate, which is the product of the other two functions. The punched-card system makes it possible to analyse the records by age, length of service, duration of absence and type of disease. For the latter purpose, London Transport uses the three-figure International Statistical Classification of Diseases and Injuries adopted in 1948 by the United Nations World Health Organization, and a discussion of suitable groupings of various diseases is included in the paper.

A number of appendixes discuss the recording and classifying of sickness absences, ways of dealing with absences occurring in separate calendar years, and methods of calculating specific absence rates. The latter refer the number of days lost by special groups of staff to the numbers employed in those particular groups. It should be pointed out that the absence rates used by London Transport are not the usual percentage absence rates used in factories, but are a measure of the number of days lost per working year, which may be 250–300 per worker, while the percentage rates refer to 100 working days.

The specific sickness absence rates, like the specific wastage rates, have the advantage that they can be used for making reasonable forecasts of the expected sickness absence of a population (given normal climatic conditions and the absence of epidemics) if particulars with regard to age, sex and length of service of the numbers exposed to risk are known. A knowledge of the likely future loss of time might prove very useful for the production, personnel and planning departments of industrial organizations.

HILDE BEHREND

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

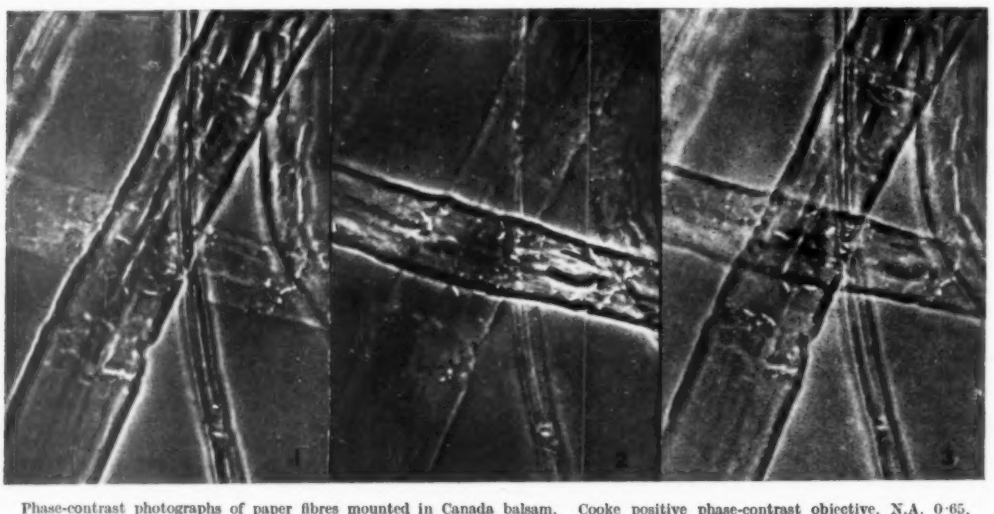
'Phase-Contrast' Methods and Birefringence

It is well known that in determining the refractive index of microscopic anisotropic objects by the methods of Becke or Schroeder van der Kolk, and their variants, it is essential to use properly oriented plane-polarized light. Now phase-contrast microscopy, interference microscopy, *Schlieren* and dark-ground illumination are essentially methods for revealing small variations in refractive index (or strictly, optical path). It would therefore seem desirable, when using these methods with birefringent objects, to employ polarized light. I have found this to be the case in certain circumstances.

The accompanying photographs show how the appearance of cellulose fibres depends on the direction of polarization. Similar appearances have been found with very many natural and synthetic fibres. In spherulites and starch grains, two arms of a polarization cross appear, and rotate with the polarizer. Such effects are best observed when the object is mounted in a medium of refractive index fairly close to the maximum or minimum refractive index exhibited by the object, when parts of the image may be made almost invisible by a suitable setting of the polarizer. If this condition does not obtain, the relative intensity variation (that is, contrast) may be too slight to detect. If the refractive index of the immersion medium is intermediate between the maximum and minimum indices of the object, the appearance of the latter alternates between dark and bright phase contrast. This effect must be distinguished from a reversal of positive phase contrast which occurs with birefringent objects producing more than a critical phase difference, depending on the absorption of the phase plate.

It has been shown[1] that even in unfavourable conditions phase contrast is an exceptionally sensitive method of micro-refractometry, and phase differences of the order of $\lambda/100$ are not difficult to detect. In principle, the sensitivity could be very considerably increased by using heavily absorbing phase plates[2,3]. It therefore appears possible that this method could be used for detecting extremely weak birefringence in biological objects, of an order similar to that described recently by Swann and Mitchison in their remarkable improvement of polarizing microscope technique[4]. The new method has the advantage that it is possible to observe the whole field of view simultaneously, and thus to see the exact relationship between birefringent and non-birefringent areas, whereas the polarizing microscope selects only the birefringent areas. On the other hand, the immersion medium must be carefully selected, and it is not always possible to use the method for living objects in aqueous media. The phase difference as measured with the polarizing microscope is, of course, independent of immersion medium (in the absence of form birefringence). It may be objected that if the phase-contrast method is to be used for the measurement, as opposed to the detection, of birefringence, inaccuracy will be introduced due to the use of relatively wide illuminating cones. The error is not likely to be large for the type of object usually observed by phase-contrast microscopy, and, if necessary, a phase plate of low angular aperture can be used.

Very striking effects were found with interference microscopy. In the case of certain liquid crystals, areas containing sharp interference fringes alternated with quite large clear areas completely devoid of fringes when monochromatic unpolarized light was used. When a polarizer was introduced, the fringes extended into the clear areas, and on rotating the polarizer by 90° a dark fringe was replaced by a bright one. This provides an interesting illustration of the fact that a birefringent crystal actually resolves light into two components, and also that in such an object the contrast may be zero unless



Phase-contrast photographs of paper fibres mounted in Canada balsam. Cooke positive phase-contrast objective, N.A. 0·65, magnification × 500

1, Single polarizer inserted; horizontal fibre almost invisible; 2, polarizer rotated 90°; vertical fibre almost invisible; 3, unpolarized light; both fibres visible, but contrast of each intermediate between Figs. 1 and 2

polarized light is used. The moral is that in using any variety of 'phase-contrast' method, a polarizer should always be available as very considerable improvements in contrast may be revealed, as well as the presence of birefringence. It would, incidentally, be interesting to study the changes in the hologram[5] of a birefringent object illuminated by polarized light as the plane of polarization is varied. Dyson[6] has shown that his interferometer microscope[7] can be used for the measurement of phase differences corresponding to about one-fortieth of a fringe. The detection sensitivity is probably much greater. When unfiltered mercury-arc light is used, delicate colour changes can be observed in birefringent objects as the polarizer is rotated. With some types of interference microscopy it is possible to observe objects producing phase changes of several wave-lengths. In such cases birefringence can be measured by counting the change in the number of fringes across the object. This is not normally possible in phase-contrast microscopy, since phase changes differing by a whole number of wave-lengths cannot be easily distinguished.

Some caution is necessary in using binocular microscopes and eyepiece camera attachments. These may incorporate semi-reflecting beam splitters which introduce a moderate degree of polarization. In many binocular microscopes the plane of polarization differs by 90° in the two eyepieces. Thus, under suitable conditions, very different images may be seen in each eyepiece, even when no other polarizer is deliberately introduced.

The results obtained with crystals, fibres and biological materials will be described in detail elsewhere.

I wish to acknowledge the help received as Johnston, Lawrence and Moseley Research Fellow of the Royal Society.

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Jan. 25.

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Electron Microscope Studies of Human Breast Cancer

While observing the presence of characteristic particles in the milks and breast tumours of certain high-breast-cancer strains of mice[1,2] and establishing the relationship between these particles and Bittner's milk factor[3,4], we have been applying the same procedures to the study of comparable human material. A preliminary report was presented to the Pathological Society of Great Britain and Ireland at Oxford in July 1949.

In the summer of 1948, Dr. Edith Paterson, of the Christie Hospital and Holt Radium Institute, Manchester, kindly supplied us with colostrum from a pregnant woman suffering from cancer of the breast. Two months later we received a further sample taken from this patient 27 hr. after parturition. Adopting the technique previously described for the preparation of extracts from mouse tissues[1,2], the presence of many spherical particles in both samples was observed. In the electron microscope these particles were similar in appearance to those associated with the Bittner milk factor in high-cancer-strain mice, though probably on the whole slightly larger.

Since this date, the milks of two other similar cases have been studied with comparable results; and in the milk from another woman suffering from a cancer of the breast which had developed after she had given birth to a child, again similar particles were found, though fewer in number.

In addition, extracts of eleven human breast cancers have been examined and in all of them we have found particles comparable with those in the milks from human cancer cases. Also, out of twelve milks from apparently healthy women, eleven presented similar particles in varying numbers. The results are summarized in the accompanying table.

Presence of particles	Breast tumour	Cancer milk	Normal milk
++	4	3	1
+	3	0	4
±	4	1	6
−	0	0	1
Total samples examined	11	4	12

++, numerous particles; +, less numerous particles; ±, only occasional particles; −, particles absent.

A comment is necessary: we have observed that the human breast tumours which contained few or very few particles could, in the main, be classified microscopically as scirrhous in type: they were tough to the knife and extremely difficult to mince satisfactorily, even with the *MSE* blender. When observed in ordinary microscopical sections, there were fewer tumour cells present than in the softer, more fleshy type of tumours, which have invariably, so far in our experience, yielded the greatest numbers of particles (Fig. 1). These two characteristics of the scirrhous tumours may affect adversely the yield of particles in our preparations, in that the mincing is necessarily incomplete and there are fewer tumour cells in any case.

In general, the extracts of human breast tumours and of the milks from women with breast cancer (Fig. 2) did not contain as many particles as did the similar extracts from the high-breast-cancer-strain mice in our earlier studies. But if some allowance be made for the special characters of the scirrhous tumours, the impression we have gained from this obviously limited experience is that there are more particles in the tumours and milks from cancer patients than in the milks from apparently healthy women.

Thus we are faced with the fact that particles related in size and appearance to those observed in tumours and milks of high-breast-cancer-strain mice are detectable, often in high numbers, in (1) human breast tumours, (2) milks from women suffering from cancer, and (3) some milks from apparently healthy women.

Gross, Gessler and McCarty[8] report the presence of particles visible in the electron microscope in the milks of female relatives of breast-cancer patients, and in some of the milks of nursing, healthy women. While the range of sizes of their particles is in general larger than ours, this may be accounted for by their somewhat different extraction technique.

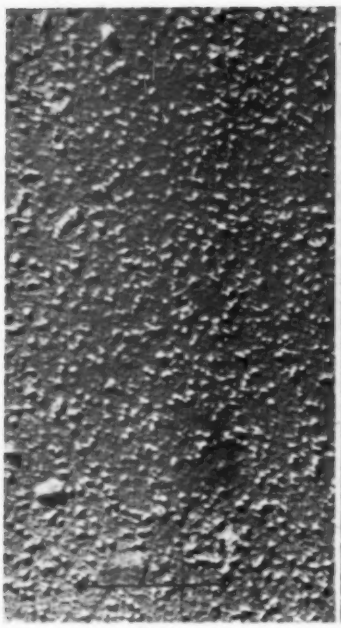

Fig. 1

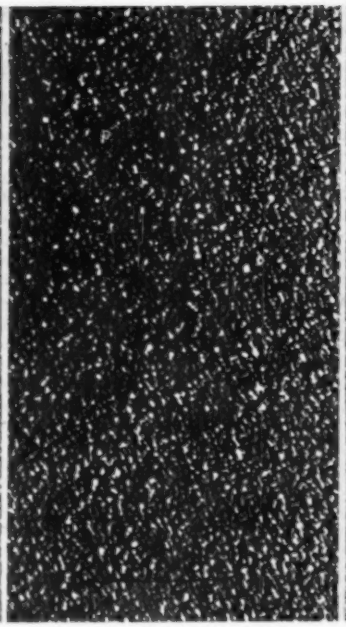

Fig. 2

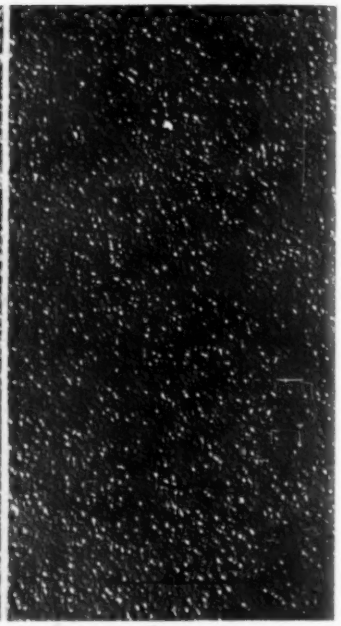

Fig. 3

Fig. 1. Human breast carcinoma; desiccated, treated with petroleum ether, extracted with distilled water, treated with trypsin, filtered through Berkefeld *N* candle. Chromium shadowed

Fig. 2. Human milk from a woman with a breast carcinoma; desiccated, treated with petroleum ether, extracted with distilled water, treated with trypsin, filtered through Berkefeld *N* candle. Chromium shadowed

Fig. 3. Human milk from an apparently healthy woman; desiccated, treated with petroleum ether, extracted with distilled water, treated with trypsin, filtered through Berkefeld *N* candle. Chromium shadowed

It is the presence of particles, similar to those in human breast cancers, in the milks of women who are apparently healthy, which must make for great caution in interpreting these results, especially in view of the one normal milk (Fig. 3) which contained a large number of particles; though the subsequent history of this case is unknown.

At present it is not possible to offer any interpretation of the particles observed in the three classes of human material; neither is it known what connexion, if any, they may have with malignant disease of the breast in man, or with the particles associated with the milk agent in high-breast-cancer-strain mice.

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Feb. 20.

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Thinning-down Effect in Nuclear Photographic Tracks

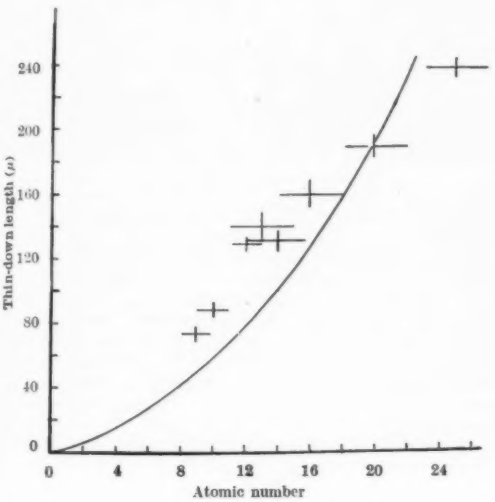
It is well known that a heavy nuclear fragment begins to capture its orbital electrons when its velocity slows down below a certain limit. Consequently, its track observed in photographic emulsion shows 'thinning-down' near the end of its range. The length L of this thinning-down depends on the nature of the nucleus. Assuming Bohr's model, Freier *et al.*[1] have carried out an approximate calculation of L as a function of the atomic number of the nucleus; their results are reproduced in the accompanying graph (solid line). It will be seen that the length L in microns can be expressed by an approximate formula:

$$L \simeq \tfrac{1}{2}.Z^2.$$

Experimentally, an accurate measurement of the length of thinning-down is rather difficult. However, we have observed[2] that along this part of the track, the cross-section of the track decreases linearly with the range. This enables us to determine the length L by the following method: using drawings made with the projection microscope (magnification 2,200), the diameter d of the track is measured along the thinned-down part for every 20 microns of range; the graph of d^2 as a function of the range R gives the ratio:

$$\frac{d^2}{R} = \frac{d_0^2}{L},$$

where d_0 is the diameter of the track before it thins down; d_0 remains constant over a certain extent of the range, and can therefore be determined with accuracy. The above relation then gives the thin-down length L, the accuracy of the method being about 10 per cent.



We have measured, in collaboration with D. Morellet, some ten tracks of heavy primary nuclei (photographic emulsion, Ilford *G*5). The results are shown in the figure by crosses. The atomic number Z was estimated by the δ-ray method.

The experimental points do not fit the curve of Freier *et al.* For the nuclei of moderate atomic number Z, the length of thinned-down track L as measured is greater than that deduced from Bohr's model. This seems to suggest that for such nuclei ($Z < 20$) the thinning-down begins with the capture of first electrons, and the capture process starts probably at a velocity greater than the limit assumed by Bohr's theory.

If a power law is assumed to represent the approximate value of the thin-down length: $L \simeq a.Z^n$, we find from our results that the exponent is near unity. As pointed out by Perkins[4], the linear variation of L with Z can be accounted for if one admits that the nucleus captures its orbital electrons at velocity $2\pi e^2 z/n.h$ (z denotes the effective charge), where the quantum number n, instead of being equal to unity as assumed by Freier *et al.*, takes the value proportional to $Z^{1/3}$.

I wish to express my thanks to Prof. L. Leprince-Ringuet for the hospitality of his Laboratory; acknowledgment is also due to Dr. D. H. Perkins for interesting discussion on the subject.

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Dec. 15.

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[4] Perkins, *Proc. Phys. Soc.*, A (Oct. 1950).

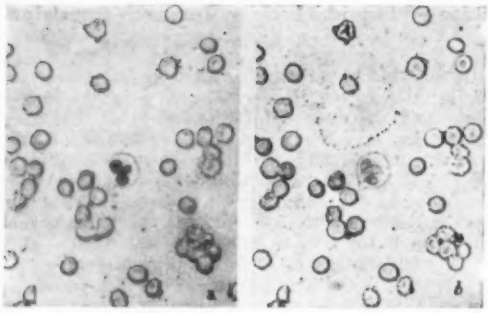
Use of Liquid Nuclear Research Emulsion in Track Autoradiography

IN a recent communication, King, Harris and Tkaczyk[1] described the use of liquid electron-sensitive emulsions in the autoradiography of biological specimens. We have used such emulsions for some time in investigations aiming at precise localization of radioactive isotopes in biological specimens by means of track autoradiography. In this communication we present some aspects of the technique which may be of interest to workers in this field.

The advantages of 'track' autoradiography over 'contrast' autoradiography in which the density of exposed grains in the emulsion is measured have been described by several investigators[2-4]. The main benefit is the possibility of quantitative estimation of the radioactive content of the specimen by counting the number of tracks emitted from it. In our work we were also concerned with the tracing of the origin of the track in order to determine the position of the radioactive atom with high precision, say, within a cell. The accuracy of such determination is limited by several sources of error: (*a*) the displacement of the emulsion relative to specimen during processing, due to lack of adhesion between them and to air locks, (*b*) distortion of emulsion due to lateral and vertical shrinkage, (*c*) chemical effects of the specimen on the emulsion and vice versa, giving rise to various artefacts[5], (*d*) osmotic pressure differences, which may cause the complete rupture of a delicate specimen.

The first of these errors can be reduced by using stripped emulsions[6] and completely eliminated by the use of liquid emulsions, which ensure an intimate contact between specimen and emulsion. This advantage of liquid emulsions was first pointed out by Belanger and Leblond[7]. On the other hand, the direct contact between specimen and emulsion aggravates the other sources of error, and we found that in order to eliminate these it is essential to separate the section from the emulsion by a protective layer. Such an impermeable layer prevents chemical action and the effects of osmotic pressure differences, and at the same time avoids shrinkage distortion by filling in the interstices and providing a plane surface on to which emulsion can be poured. In order not to reduce the length of the observable track and thus impair the accuracy of localization, the protective layer has to be as thin as possible. A medium has therefore to be used which can provide very thin and yet strong and impermeable layers. Other factors influencing the choice of the medium are: good adhesive properties to glass, section and emulsion, and chemical stability in the presence of developing reagents.

After trying out films of glass, mica, collodion, Canada balsam and distrene, we found that most satisfactory results are obtained by using 'Perspex'. The procedure is as follows: the specimen, for example, blood cells labelled with a radioactive isotope, is mounted on a slide and suitably stained. It is then covered with a 1 per cent solution of 'Perspex' in chloroform; the quantity of this solution has to be estimated in relation to the thickness of the section, so as to give a layer about one micron thick when dry. Next the section is dried over a period of several hours to prevent wrinkling of the surface. A trace of Canada balsam is smeared over the 'Perspex', to improve adhesion, and freshly melted Ilford *G*.5 emulsion is poured to the required



thickness. The whole is dried rapidly at room temperature by reducing the pressure to about 10 cm. mercury; this helps to force out air bubbles in the emulsion. After a suitable period of exposure the emulsion is processed in the usual way; but the plates have to be carefully washed, since traces of hypo increase the risk of peeling.

By using this method the cells appear to emerge from the treatment unharmed, and no distortion is observed either in the specimen or in the emulsion. Photomicrographs of a section obtained by this method, before and after coating with the *G.5* emulsion, are reproduced herewith; the section contained blood cells labelled with radioactive zinc. Zinc-65 is not very suitable for track autoradiography; but it was used in the study of a problem which will be described on another occasion. The erythrocytes and leucocyte, which are seen on the microphotograph together with an electron track (*b*), appear exactly the same as on the original section (*a*).

This work has been carried out with the aid of a grant from the Medical Research Council, to which we express our indebtedness.

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Excitation of Nitrogen in a Sodium Arc

Spectrograms have been obtained of a high current-density sodium arc obtained with a low-dispersion Hilger quartz spectrograph, in the region of 4000–2000 A. The cathode was a sodium pool in a 'Pyrex' glass tube of about 2 cm. diameter, and the anode was a hollow nickel-plated iron rod cooled by a stream of oil. The voltage supply for the high-current arc (2–6 amp.) was obtained from a 120-volt storage battery, and the low pressure inside the tube was maintained by a 'Cenco Hyvac' pump.

The first negative bands of nitrogen are brought out prominently along with the principal series lines of sodium at the higher current strengths used. Herman[1] found an increase in the intensity of the first negative system, after the break-up of a glow discharge in nitrogen, and ascribed it to the recombination of N_2^{++} ions with electrons. In the sodium arc containing an admixture of nitrogen, the excitation of nitrogen, presumably, arises from the collisions of the first kind between electrons and ground-state $X'\Sigma N_2$ molecules[2].

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De Haas - van Alphen Effect in Aluminium and Antimony

The de Haas – van Alphen effect (periodic field dependence of magnetic susceptibility) has been found in aluminium and antimony single crystals at 4·2° K. and lower temperatures. The effect depends in a complicated way on the direction of the magnetic field, and there are complicated modulation effects similar to those previously found in other metals[1]. Typical values of the period at 15,000 gauss are 400 gauss in aluminium and 270 gauss in antimony; the amplitude in both metals increases by a factor of order 4 when the temperature is reduced from 4·2° K. to 1·5° K. Aluminium is the first metal of cubic symmetry in which the effect has been found.

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March 10.

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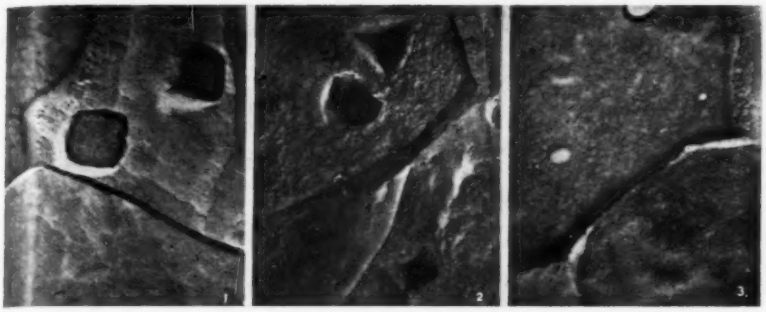
An Examination of Weld Metal by means of the Electron Microscope

During a recent investigation into the cause of variation in the temperature of transition from rough to brittle behaviour of weld metal, the X-ray powder diffraction patterns of the non-metallic inclusions separated from different samples gave evidence of the presence of crystalline rhodonite (a manganese silicate belonging to the triclinic system) in weld metal of low transition temperature only, whereas chemical analysis indicated the same elemental composition of the inclusions in all cases.

Examination by means of the optical microscope failed to confirm this observation, and as a result two samples of weld metal having high and low transition-temperatures were sent to this Laboratory for electron microscopic examination.

Negative 'Formvar' replicas, shadowed with chromium at an angle of 1 to 4, were made in the normal manner after the metals had been polished and etched. The etching consisted of a ten-minute treatment with a cold 5 per cent solution of hydrochloric acid (sp. gr. 1·18 aqueous) in ethanol, in which rhodonite is known to be soluble, followed by a light treatment with 2 per cent 'Nital' to bring out the normal microstructure. Several replicas were taken off each sample to ensure that any observed differences were truly representative.

Replicas taken from the low-transition-temperature metal revealed numerous well-defined pits, of which those seen in Figs. 1 and 2 (× *c.* 8,600) are typical.



These pits were randomly distributed throughout the replica specimens, and can probably be attributed to rhodonite inclusions in the sample. Only a very few isolated pits of similar appearance could be found among the specimens prepared from the high-transition-temperature metal; but it was noticed that pronounced attack had occurred along a number of grain boundaries in which segregation appears to have taken place. This effect is typified in Fig. 3 (× c. 8,600), and could be explained by assuming the segregation of rhodonite in a fine amorphous form.

This work provides an example, rare in practice, in which the electron microscope can be used to advantage for the examination of non-metallic inclusions.

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An External Cathode Hard-Glass Geiger–Müller Tube

In the course of work on the development of Geiger–Müller counters in this laboratory, some interesting properties of a hard-glass external cathode ('Aquadag') counter have been observed. Argon–alcohol counters filled to a pressure of 10 cm. of mercury, having internal diameters of one inch, and using a 7-mil central tungsten wire, were found to have plateaux extending from 1,200 volts to more than 3,000 volts. The slope of these plateaux was generally found to be less than 0·4 per cent per 100 volts. It was noted that the size of the pulses obtained from these counters is reduced with enhanced rate of counting. This phenomenon results in an apparent upward shift of the threshold voltage with increased rate of counting. The slope and length of the plateau remain unaffected by incidence of strong radiation, and the shift in the threshold voltage can be nullified by using a preamplifier at the input of the scaler. The decrease in pulse size and the consequent increase of the threshold voltage are shown in Fig. 1.

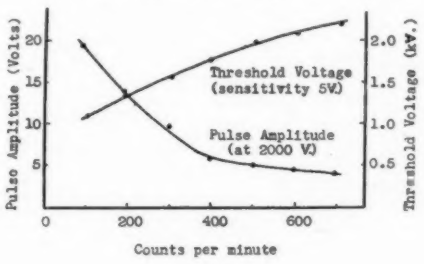

Fig. 1

The dead time of these counters has been found to be of the order of 3×10^{-4} sec., and compares not too unfavourably with that of 2×10^{-4} sec. generally reported for internal cathode counters[1]. With the use of a single tube preamplifier the counter efficiently recorded more than 4,000 counts per minute and showed a characteristic which has been plotted in Fig. 2.

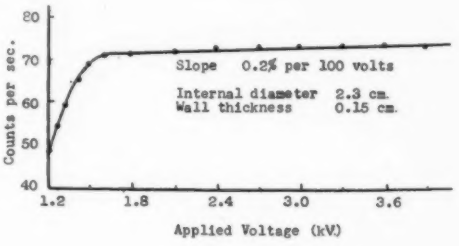

Fig. 2

A more complete account of this counter and a discussion of the results will shortly appear elsewhere.

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Nov. 16.

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Electrical and Optical Characteristics of D.C. Corona Discharge

English[1] has recently described the application of a photomultiplier—wide-band (100 Mc./s.) amplifier—oscilloscope technique to the study of the visible radiations emitted by the pre-onset streamers[2-4] in D.C. corona. Independently, similar techniques have been used in this laboratory during the past year for the study of positive point-to-plane corona (following earlier applications of similar techniques to spark channels[5,6] and impulse corona[7,8].).

The apparatus used included a conventional amplifier, having a rise time of 0·05 μsec., and an oscilloscope[9,10] using a 10,000-volt cathode-ray tube. The light pulses from pre-breakdown streamers in corona in air at atmospheric pressure are similar in shape but much longer (0·4 μsec. at 30 per cent of maximum pulse height) than those recorded by English (0·06 μsec.). Although the band-width of the apparatus

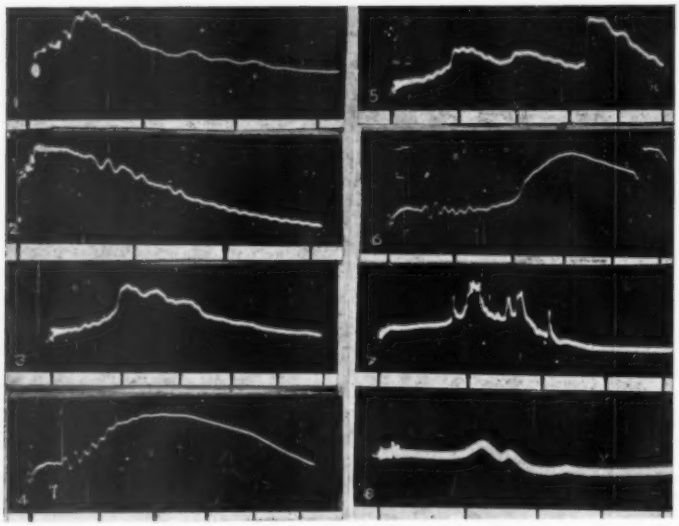

Fig. 1. Hydrogen light pulse. Calibration marks 0·5 μsec.
Fig. 2. Hydrogen current pulse. Calibration marks 1 μsec.
Fig. 3. Normal nitrogen light pulse. Calibration marks 1 μsec.
Fig. 4. Normal nitrogen current pulse
Fig. 5. Nitrogen light pulse showing the beginning of a second pulse.
Fig. 6. Nitrogen current pulse conditions similar to Fig. 5
Fig. 7. Argon light pulse. Calibration mark 5 μsec.
Fig. 8. Argon current pulse
Note. The ripples at about 0·6 μsec. on each electrical pulse are induced by the initiation of the hydrogen thyratron time-base

is much smaller than that used by English, it has, in the course of normal calibration work, recorded light pulses considerably shorter than those obtained from the air corona, and it appears unlikely that the discrepancy is due to instrumental deficiencies. Observations have been made both on pre-breakdown and pre-onset streamers, and the effect on pulse duration of circuit resistance, external irradiation and point radius has been found to be negligible. It is proposed next to construct an amplifier of greater band-width, of the order of 100 Mc./s.

Observations have been made on argon, oxygen, hydrogen and nitrogen, and in all cases except oxygen the pulses are so long that they are affected by amplifier band-width to an even lesser degree than the air pulses. The oscillograms reproduced herewith show the light pulses from the whole discharge; experiments relating to different parts of the discharge will be described in a later publication.

Brief descriptions are given of the records obtained for discharges in several gases at atmospheric pressure for a point radius of 0·09 mm., a gap-length of 5–8 cm., a 22,000-ohm resistance in series with the point and a measuring resistance of 20–60 ohms between the plane and earth.

Hydrogen. All the light pulses are similar to that shown in Fig. 1, having a duration of about 1 μsec. with a time of rise of about 0·25 μsec. The current-pulse induced at the plane is about 3 μsec. long, the time of rise not being recorded (Fig. 2).

Nitrogen. A typical light pulse (Fig. 3) is about 5·5 μsec. long with an initial rise to about 30 per cent of maximum amplitude in about 0·15 μsec. followed by a slower (1 μsec.) rise to the peak value. The current pulse (Fig. 4) shows an initial plateau about 1·0 μsec. long, the overall duration being about 5·5 μsec. The pulses vary considerably in shape; sometimes a second pulse, with a very short time of rise, follows closely on the tail of the first pulse, as in Figs. 5 and 6. The long pulse durations are associated with long streamers. The addition of small quantities of air shortens the pulses very considerably.

Argon. Streamers and light pulses are again long; the latter (see Fig. 7) are about 15 μsec. in duration and show a 1·0-μsec. rise followed by a 2·5-μsec. plateau and finally an erratic region which probably results from a filamentary discharge associated with, but distinct from, the streamers. This discharge is probably closely related to the glow described by Loeb[11] for D.C. corona and the impulse discharges described by various authors[8,12–16]. It is particularly strong in argon. The induced current pulses are similar in duration but do not show this erratic region.

Oxygen. Detailed results were not obtained; but the light pulse is considerably shorter than in air.

It is hoped to publish details of this work elsewhere.

One of us (H. M. G.) wishes to acknowledge generous financial assistance from the Electrical Research Association.

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A Strange Feature of Einstein's most Recent Generalized Field Theory

Einstein and Straus[1] developed a unified field theory in which the field variables consist of sixteen elements $g_{\mu\nu}$ ($\mu,\nu = 1, 2, 3, 4$) of a non-symmetric tensor connected by a number of field equations. Schrödinger[2] also propounded a similar theory in which the field equations are nearly the same except that they contain additional terms involving a parameter λ, which takes a role analogous to that of the cosmological constant. Einstein's field equations will follow from Schrödinger's equation if we put $\lambda = 0$. Though there exists at present some confusion regarding the interpretation of the field variables,

yet the most plausible and apparently most natural interpretation is to take the symmetric part of the tensor as the metric and the antisymmetric part as the electromagnetic tensor. The solution of Einstein's field equation for the case

$$g_{11} = -\alpha(r),\ g_{22} = -r^2,\ g_{33} = -r^2\sin^2\theta,\ g_{44} = \nu(r),$$
$$g_{14} = -g_{41} = w(r),$$

can be obtained by writing $\lambda = 0$ for corresponding solutions of Schrödinger's field equations obtained by Papapetrou[2], and will be as follows:

$$\left.\begin{aligned} \frac{1}{\alpha} &= 1 - \frac{2m}{r} \\ \nu &= \left(1 + \frac{e^2}{r^4}\right)\left(1 - \frac{2m}{r}\right) \\ w &= \frac{e}{r^2} \end{aligned}\right\} \qquad (1)$$

It is very natural to interpret m as mass and e as charge in this case.

Now, Einstein[4] has recently changed his field equations again, which for the above case adds an additional equation,

$$2\,\frac{d}{dr}\left(\frac{w}{r\alpha}\right) + 6\,\frac{w}{r^2\alpha} = 0, \qquad (2)$$

over and above those which lead to (1). (The left-hand side of (2) was obtained by Papapetrou, who, it seems to me, made a numerical error in calculating it. This, however, did not affect the final result, as the expression did not enter the final equations. I am indebted to my father, Dr. B. B. Banerji, for checking my calculations in this connexion.) The consistency of (2) with the set which leads to (1) can be tested by substituting (1) in (2). This gives:

$$-4\,\frac{e}{r^3}\left(\frac{1}{r} - \frac{2m}{r^2}\right) + \frac{2e}{r^2}\left(-\frac{1}{r^2} + \frac{4m}{r^3}\right) + 6\,\frac{e}{r^2}\left(\frac{1}{r^2} - \frac{2m}{r^3}\right) = 0,$$

which is satisfied only if either $e = 0$ or $m = 0$. This shows a strange feature of the recent field equations of Einstein, namely, that with the very natural interpretation of e and m suggested above, the existence of an isolated charged mass is excluded, whereas isolated massless charge (and certainly also chargeless mass) can exist.

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A Unit of Wave-Number

WAVE-NUMBERS are more convenient than wavelengths, not only in absorption and the dispersion of a prism[1], but also in atomic spectra, hyperfine structure and in the theory of resolution[2].

The objection to 'cm.$^{-1}$' is, however, less the size of the unit than the inconvenience, not to say obscurity, of the multiples and sub-multiples. '10^{-2} cm.$^{-1}$' is doubtless correctly written 'm.$^{-1}$', but few would use the synonym. Call 'cm.$^{-1}$' by some new name, such as 'Rydberg', however, and the difficulty disappears. Absorption can be conveniently recorded in 'kilo-rydbergs' or 'kR', and hyperfine intervals in 'mR'.

The name 'Rydberg' was suggested to me many years ago by Prof. H. Dingle. Wave-numbers were, I believe, introduced by Johnstone Stoney, but first widely used by Rydberg in his famous formula.

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[1] Bayliss, N. S., *Nature*, **167**, 367 (1950).
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Human Immersion and Survival in Cold Water

IN examining the problem of survival of men immersed in cold Arctic waters, it is clear that the rate of cooling of the body will be of signal importance, and Glaser[1] has recently directed attention to the fact that heat losses from the human body immersed in cold water can be balanced, and the temperature of the deep tissues maintained, by exercise. In addition, however, survival may well depend very significantly on the maintenance of some degree of *manual dexterity* for clambering on to rafts, wreckage, etc.

Recent studies by one of us (C. W.) in the Arctic have shown that when the rate of heat production (due to exercise) not merely balances but even exceeds the loss, the temperature of the deep tissues (as measured in the rectum) rises, and this then influences very markedly the surface temperature of hands and feet[2]. Thus, when men were exposed at rest in relatively light winter clothing on the flight-deck of an aircraft carrier in the Arctic, the surface temperature of the hands occasionally fell below 10° C., so that they were useless for fine manipulations. The deep tissues cooled more slowly. At this stage, mild exercise (150 kgm.cal./m.^{2}/hr.) caused the temperature of the deep tissues to rise soon after exercise began, and control-levels were regained at approximately one hour from the commencement of exercise. Hands and feet continued to cool for the first three-quarters of an hour of exercise and then warmed abruptly, reaching levels which were often higher than those observed at the beginning of the experiment. In the particular exercise employed (step-climbing), most of the additional heat is produced in the lower limbs; hence the rise in temperature of the hands is probably due to a reflex mechanism and not to local heat production in the muscles of the upper limbs.

Such rewarming of hands which had previously cooled was so striking as to suggest that the cooling of bare hands might be more than compensated by an outflow of heat from the deep tissues generated as the result of severe exercise. To test this probability, volunteers ran about the flight-deck in severe cold, with air temperatures as low as − 10° C. and wind-velocities up to 18 knots, for two periods of ten minutes each, at a rate of approximately 7 m.p.h. In the first period of exercise the men wore heavy body clothing but the hands were bare; in the second period, which followed immediately on the first, only shorts, vest and plimsolls were worn. After the first

bout of exercise, the temperature of the deep tissues rose to 102° F. and the surface temperature of the fingers rose also, in some instances above 30° C. After the second bout, the temperature of the deep tissues was relatively unaltered, and although the temperature of the fingers fell somewhat, they were rarely below 20° C. Such temperatures are quite comfortable and allow of fine manual manipulations. However, the areas which are relatively poorly supplied with vasomotor nerves (nose, cheeks, ears, outer arm and forearm) did become frozen during the second bout of work. In one instance, cooling of the forearm was so great that temporary paresis of the extensor muscles occurred. However, the warming of the fingers associated with a raised body temperature permitted the use of the hands for fairly complex tasks such as buttoning a coat. Cooling of muscle masses beneath areas of skin which are relatively poorly supplied with vasomotor nerves will clearly limit the length of time during which men immersed in cold and wet clothing will be able to use the upper limbs for swimming.

The manner in which these physiological mechanisms operate may be appreciated more readily in terms of a simple physical model[3] of the various physical and physiological factors involved. In our model, deep tissues and superficial tissues are regarded as relatively independent in their thermal behaviour[4,5]. They are, therefore, represented by separate heat capacities which are joined by a variable 'average' heat conductance representing the ability of the body to vary the rate of blood-flow between the deep and superficial tissues and also within the superficial tissues. The control channels of the rate of heat-flow in this conductance are very analogous to 'servo-mechanisms', now familiar in engineering. They are very sensitive to change in temperature of the deep tissues and considerably less to changes in temperature of the superficial tissues[3].

The model brings out clearly that the relatively slower rate of cooling of the deep tissues in a cold environment compared with the superficial tissues is due to an increase in the average resistance to heat-flow from the deep to the superficial tissues, and therefore to a greater proportional loss of heat from the superficial tissues. Such a sudden restriction in the rate of heat-flow from the deep tissues may, in fact, in the first few minutes of exposure to cold, cause a paradoxical *rise* in temperature of the deep tissues, because the rate of heat production continues at much the same rate. The rate of cooling of the superficial tissues has a relatively well-defined time-constant given by the product of their heat capacity and the thermal conductance by radiation and convection from the skin to the surroundings. The relatively independent behaviour of the two heat capacities is well demonstrated during exercise in cold. During the first three-quarters of an hour of exercise, the hands and feet continue to cool at the same rate as before. Only when the temperature of the deep tissues is raised above control-levels does the resistance to heat-flow between the deep and superficial tissues decrease. This then occurs suddenly, and the abrupt increase in heat-flow from the deep tissues is manifested in a rapid rise in the temperatures of hands and feet. These two areas will, of course, demonstrate these effects more markedly than other areas of the human body as they are relatively rich in vasomotor nerves, the control mechanism which varies the rate of blood-flow in the peripheral vessels. Calculations of the rate of cooling of the human body immersed in cold water should, in general, clearly take account of the relatively independent behaviour of these two heat capacities.

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Evolutionary Importance of the South African 'Man-apes'

In the past, the discovery of any man-like fossil has signalled the beginning of extended and heated controversy. After reading numerous recent publications on the South African 'man-apes', we have come to feel that history is repeating itself. The great importance of this remarkable series of fossils is being obscured by technical argument over minor points and by the creation of genera, and even subfamilies, of doubtful utility. The present controversies over the South African fossils started before the discovery of many of the best preserved and most critical specimens, and a general statement of opinion now may help to orientate discussion when these latest finds are described in detail. The basic ideas expressed here are not new, but the emphasis is perhaps different.

The human ilium is a very distinctive, highly specialized bone, which is an essential part of the complex that makes possible efficient bipedal locomotion. Among all mammals, the human ilium is approximated *only* in the South African 'man-apes'. If the pelves only of these forms had been discovered they would surely have been attributed to man, and possibly even to the genus *Homo*. But the skulls associated with these pelves have small cranial capacities. Thus, the great evolutionary importance of the 'man-apes' is that they show the *initial* division between ape and man to be a locomotor adaptation. This fundamentally alters certain traditional theories of the origin of man and is in accord with Edinger's discoveries of the course of brain evolution in other mammals. It has long been recognized that different parts of the body may evolve at different rates, although it seems to have been particularly difficult for many to apply this idea to man; the conception that all parts should evolve at comparable rates has been one of the main reasons for the refusal to accept unusual associations in the case of many human fossils.

Since it now appears from the South African fossils that the rates of evolution of different parts of the body have been so different, comparisons of arboreal ape, 'man-ape' and man that are based on different parts of the skeleton will give quite different results. For example, the humerus is very similar in ape, 'man-ape' and man. If it is accepted that the human line became distinct from that of the arboreal apes primarily because of the bipedal adaptation, and that evolution proceeded at very different rates in other parts of the body, the original difference between ape and 'man-ape' may have been largely

in the ilium. It is perfectly consistent to maintain that the 'man-apes' had separated from the arboreal apes and were on the way to becoming man, and yet, in the sum total of their anatomy, they were more like apes than men. It is the beginning of a new trend, a new adaptation, that is important, and not the sum of all anatomical details.

In the skull and dentition, there are features that definitely suggest evolution in the direction of man. These serve to strengthen and corroborate the evidence of the pelvis, but, taken by themselves, they would scarcely be sufficient to prove a close relationship. The fragments of the femur, likewise, are compatible with the idea that these forms were bipeds, but alone would not be sufficient to prove it. It is the ilium that shows the close approximation to man, and also indicates upright, bipedal locomotion. Even if the teeth were more like those of apes than they are, the main interpretation and significance of these forms would not be altered.

Whether the South African 'man-apes' were direct ancestors of man or collateral cousins depends on distribution and dating. It is quite possible that such forms ranged throughout the Old World tropics (*Meganthropus* of Java may well be closely related), and that evolution was proceeding over wide areas, rather than in one restricted region; but the dating of these fossils is uncertain.

So far as taxonomy is concerned, if the basic adaptation separating the human line from the ape line is bipedal locomotion, then the easiest way to express the facts is to place the 'man-apes' in the family Hominidæ. The family might conveniently be divided into two genera, *Australopithecus* and *Homo*. But the main evolutionary significance of the 'man-apes' is independent of the names ultimately applied. These fossils exhibit an unanticipated combination of features, illuminating the problem of the evolutionary transition from ape to man. Our gratitude is due to their discoverers, Dr. R. Broom, Prof. R. A. Dart and Mr. J. T. Robinson.

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Experiments on the Cause of Dorsiventrality in Leaves

In flowering plants, a leaf primordium may be initially centric in shape[1]; but on further growth it becomes dorsiventral, a phenomenon of which the mechanism is but little understood. Results from experimental treatments of the shoot apex of the potato, *Solanum tuberosum*, shed new light on this phenomenon. The leaves arise in spiral sequence, with an average divergence angle of 138°. Primordia visible at the time of the operation will be called P_1 and P_2; P_1 being the younger. The first leaf to arise after the operation, but initially invisible, will be called I_1.

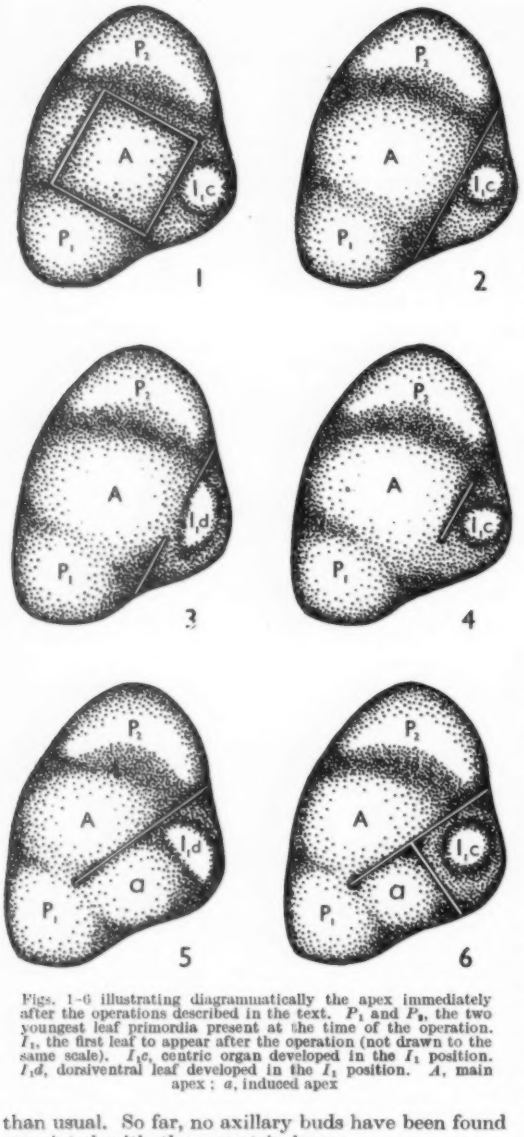
When the apical meristem of *Solanum* is isolated from the adjacent leaf primordia by four vertical incisions, a new leaf may arise on the meristem outside the cuts and it is sometimes centric. These centric organs occupy the I_1 position and are particularly interesting in view of recent experiments on the fern *Dryopteris aristata* reported by Wardlaw[2], who obtained solenostelic buds in positions normally occupied by leaves, when these were isolated from the apex by small tangential cuts. He considers that primordia of leaves and buds in *Dryopteris* are histologically identical. A leaf primordium develops under conditions where the growth-rate is greatest on the abaxial side, and where the adaxial side is probably subjected to inhibitive effects proceeding from the shoot apex; hence its dorsiventral symmetry. But buds, which typically develop on subapical or mature regions and thus may not be subjected to these unevenly distributed influences, are radially symmetrical.

As a result of various experimental treatments of the apex of *Solanum*, dorsiventral leaves have been observed to arise with an abnormal orientation to the main apex, but always with the adaxial face turned towards a newly formed apex. Dorsiventrality is apparently due to a basipetal inhibiting effect proceeding from the apical meristem. Surgical operations have been devised to test this hypothesis more fully. Six of these are shown in Figs. 1–6. When the apical meristem is isolated by four vertical cuts (Fig. 1), I_1 often develops centrically. The position of the cuts has a considerable effect on the development of I_1. When a cut is made close to the presumptive position of I_1, a centric organ develops; but if the cuts are close to the apex, a dorsiventral leaf is formed.

Evidence relating to the factors determining dorsiventrality was obtained by performing the operations shown in Figs. 2–4. When the I_1 position is isolated by a cut extending across the apex, from the edge of P_1 to the edge of P_2, a centric organ is formed (Fig. 2). When I_1 is isolated from lateral influences arising in or near P_1 and P_2, but when a direct path to the apex still remains, a dorsiventral leaf is formed (Fig. 3). If, however, I_1 is isolated from the apex by a small cut which does not extend to the margins, the primordium develops centrically (Fig. 4). By varying the size of this cut it is possible to alter the shape of I_1. If only a very small cut is made, a dorsiventral leaf is formed; if the cut is slightly larger, the leaf is at first nearly centric, but later develops a narrow lamina.

The most convincing evidence in support of the hypothesis was obtained by making cuts of the type shown in Figs. 5 and 6. Ball[3] has shown that when the apical meristem is divided, the lateral segments form new apices; these give rise to leaf primordia and grow as normal shoots. When the I_1 position is isolated and the apex unequally divided by a cut extending from the edge of P_2 to the mid-point of P_1 (Fig. 5), a new shoot apex is often formed in the smaller segment ('*a*' in Fig. 5). When I_1 arises it is dorsiventral and orientated at right angles to the new apex (and deflected up to 25° from its normal direction). Additional proof of the apical control of dorsiventrality can be obtained by making a second cut at right angles (Fig. 6) midway between the P_1 and I_1 positions. In these experiments I_1 is centric.

The size and structure of the centric organs vary greatly. Some lose their meristematic activity at an early age and consist only of parenchyma. These have no vascular supply and cause no disruption of the stem vascular tissue. In the more elongated ones (which, however, do not become as long as the normal leaves) a protostelic vascular strand may reach almost to the tip, though in most cases it fades out below this point. In some specimens there is a more or less extensive solenostelic region near the base. The leaf-trace connects with the vascular system of the stem through a leaf gap which may be narrower



Figs. 1–6 illustrating diagrammatically the apex immediately after the operations described in the text. P_1 and P_2, the two youngest leaf primordia present at the time of the operation. I_1, the first leaf to appear after the operation (not drawn to the same scale). I_1c, centric organ developed in the I_1 position. I_1d, dorsiventral leaf developed in the I_1 position. *A*, main apex; *a*, induced apex

than usual. So far, no axillary buds have been found associated with these centric leaves.

The formation of centric organs instead of dorsiventral ones has been reported on several occasions. Versluys[4] observed that a centric bract often arose from the remainder of the apex after the formation of axillary flower primordia in the cherry. Lang[5] found that, by destroying the apical regions of the shoot of *Osmunda regalis*, organs which appeared to be centric leaves were frequently produced. These often bore lateral or terminal sporophytic buds, and sometimes the tip gave rise to a prothallus. M. and R. Snow[6] have described radially symmetrical organs on experimentally incised apices of *Epilobium hirsutum*; they attributed the form of these organs to the almost terminal position which they occupied. Wardlaw[7] obtained awl-shaped leaves with reduced vascular strands in *Onoclea sensibilis* grown under conditions of high humidity and low light intensity. This resulted in apical inactivation and a concomitant development of abnormal leaves. As a result of isolating very young leaf primordia of *Dryopteris* on plugs of pith, he was able to convert these into centric organs with a solenostelic vascular strand[8]. The growth of these organs was extremely limited. Results of this kind have previously been interpreted on a nutritional basis[7,8]; but it is apparent that in all the cases cited above, the production of centric organs is closely related to a cessation of apical growth, or to an elimination of its effects. The experimental results now reported support this conclusion.

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Wax Secretion in Insects

While it is generally agreed that insects and their eggs conserve water by the use of specialized layers of wax[1–3], no clear explanation exists as to the mechanism of wax secretion.

In the cuticle of *Rhodnius*[1,4], and the egg of the red spider mite[5], the waxes are known to be secreted in a mobile, if not liquid, form; in these and many others, these waxes harden to a crystalline solid in a comparatively short time. The wax secreted by Gené's organ in ticks[6] becomes much less mobile soon after its application to eggs. In contrast, the cockroach is waterproofed by a grease which remains mobile throughout life[7].

It has recently been observed that a sample of grease extracted from cockroach cuticles and left exposed to the air at room temperature for three months becomes a hard white crystalline material. The grease has a melting point of approximately 34° C.; the final product, which is a wax, melts sharply at about 55° C. Samples of the original grease have been sealed in small tubes in oxygen and nitrogen, and kept in light or dark for three months without apparent change; the melting point does not alter by more than three or four degrees in these circumstances. On the other hand, after a sample of grease has been heated carefully in air or *in vacuo* at a temperature of about 100° C. for some minutes, its melting point rises by several degrees, and after an hour's heating, a hard white wax is obtained which melts at 55–60° C. This melting point is not affected by prolonged further heating.

It would seem that we can eliminate the possibility of oxidation or polymerization changes in such inert materials as these waxes[3], and conclude that they are secreted in a solvent which evaporates slowly. In the cockroach, the continual activity of the œnocytes[8] suggests that grease, or perhaps solvent, is being secreted continuously throughout life to replace loss. In other insects, the existence of a more volatile solvent, which evaporates rapidly after secretion, would explain the observed facts.

Work is now in progress to identify the volatile material in cockroach grease, and to examine the possibility of wax solvents being concerned in the secretion of waterproofing layers in other insects.

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A Depressant Effect of Adrenaline on the Rat Diaphragm

It is well known that adrenaline usually augments the contractions of striated and cardiac muscle; this is also true of the isolated phrenic nerve diaphragm preparation of the rat stimulated rhythmically, especially if it is depressed by excess potassium.

Goffart and Brown[1], in 1947, reported a depressant action of adrenaline correlated with a low intramuscular potassium, and it has now been found that when the Krebs–Ringer solution in which the preparation is placed is modified to contain less than 2·5 mgm. per cent calcium, adrenaline at a concentration of $1/10^7$–$1/10^8$ produces a marked and rapid depression of the responses to electrical stimulation. The depression is preceded by a brief potentiation and is followed by a slower spontaneous recovery, the whole response taking 15–30 min. The extent of the depression produced varies somewhat as the initial contraction height, but its duration is never proportionately increased. From similar experiments in Tyrode's solution, potassium ions appear to be essential for the recovery.

The depression is not present in denervated muscle, but occurs in neuromuscular block brought about by curare and by complete absence of calcium.

This observation is in accord with the observation of McDowall and McWhan[2] that blood vessels perfused with Ringer's solution deficient in calcium are dilated by adrenaline, and with those of many observers who have found that adrenaline may depress the perfused heart under similar conditions.

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Pyruvate Metabolism in *Saccharomyces cerevisiæ*

It is generally assumed that *Saccharomyces cerevisiæ* (baker's yeast) can metabolize pyruvate: (*a*) by simple decarboxylation, a reaction not requiring oxygen, catalysed by carboxylase[1], and (*b*) by oxidation, as described by Lieben[2] and Meyerhof[3], an oxygen-requiring reaction the precise mechanism of which is not known. In this communication experiments are briefly described which provide a general explanation of the mechanism of pyruvate aerobic oxidation by yeast and determine the role of carboxylase.

Pure suspensions of starved, pressed baker's yeast have been used for the experiments. General methods are the same as in a previous communication[4]. The oxygen uptake and carbon dioxide evolution were measured by the Warburg direct method[5]. Pyruvate was estimated with the Friedemann and Haugen[6] or the Straub[7] method, with consistent results. All experiments have been carried out at *p*H 4·5, corresponding to the physiological hydrogen ion concentration of the medium for the growth of *S. cerevisiæ*[8].

Table 1. Effect of Dicarboxylic Acids and Carbon Dioxide on Pyruvate Consumption.

5·7 mgm. yeast (weighed after drying at 100°) suspended in 2·0 ml. 0·05 *M* buffer, in Warburg flasks with air, or air and 5 per cent carbon dioxide, in the gas space. Potassium hydroxide in the central well of the flasks filled with air. 60 μM pyruvate added after 30 min. equil. Final *p*H, 4·5. The figures represent μM pyruvate consumed after 90 min. incubation, at 30°, and allow for the respective controls.

Medium	Atmosphere	
	Air	Air and 5% carbon dioxide
Phthalate	10·4	17·0
Succinate	17·0	16·4
Fumarate	18·7	17·9
l-Malate	18·0	18·3

Our results can be summarized as follow. (1) At *p*H 4·5, living yeast cells consume pyruvate only in the presence of oxygen, as earlier reported by Smythe[9], notwithstanding the significant amount of carboxylase present in the cells, as proved by (*a*) the ability to ferment glucose, evolving carbon dioxide under strictly anaerobic conditions, and (*b*) the intense carboxylatic activity of the saline extracts obtained from the cells after drying. (2) C_4-dicarboxylic acids stimulate the aerobic pyruvate consumption by the yeast cells (Table 1). It may be admitted that the effect of dicarboxylic acids is produced with about the same concentration activating pyruvate oxidation by the brain pyruvate oxidase[10] as the concentration of the acids inside the yeast cells is 5–10 times smaller than in the suspension medium[11]. Dicarboxylic acids replace the stimulating effect of carbon dioxide on pyruvate consumption, earlier described by Brandt[12], and confirmed by our experiments. This implies that the effect of carbon dioxide may be mediated through synthesis of a dicarboxylic acid (Wood and Werkman reaction[13]). (3) Dinitrophenols, some of which (for example, the 2,4-compound) dissociate oxidation from phosphorylation and interfere with oxidations where the substrate activation is apparently dependent on a phosphate exchange[14], inhibit intensely pyruvate oxidation and the corresponding carbon dioxide formation (Table 2). At *p*H 4·5 the pI_{50} ($-\log_{10}$ molarity inhibiting 50 per cent pyruvate consumption) is 4·50, 3·50 and 3·72 for 2,4-, 2,5- and 2,6-dinitro-

Table 2. Effect of 2,4-Dinitrophenol on Pyruvate Oxidative Decarboxylation

12·1 mgm. (dry wt.) yeast, suspended in 0·05 *M* phosphate with 52·0 μM pyruvate. *p*H 4·5. Air in the gas space. The figures represent μM oxygen or pyruvate consumed and carbon dioxide evolved after 90 min. incubation, at 30°, and allow for the respective controls. Relative inhibition in parentheses.

Inhibitor	CO_2	O_2	Pyruvate
None	12·5	10·3	10·8
10^{-4} *M* 2,4-dinitrophenol	1·2 (90·4)	1·3 (87·4)	0·8 (92·6)

phenols, respectively. The effect of dinitrophenols depends greatly on the *p*H of the yeast suspension medium and cannot be detected at *p*H 7·3. At about *p*H 6·0, 2,4- and 2,6-dinitrophenol ($7 \cdot 0–1 \cdot 0 \times 10^{-4}$ *M*) do not affect significantly the activity of a carboxylase preparation, purified according to Green *et al.*[15], but 2,5-dinitrophenol ($6 \cdot 4 \times 10^{-4}$ *M*) inhibits it to the extent of 61·5 per cent. In the presence of pyruvate and dinitrophenol, at concentrations wholly or partially inhibiting pyruvate oxidation, no acetaldehyde accumulation can be detected, the oxidation of which by yeast is intensely inhibited by dinitrophenols[16]. It must be pointed out that the same concentrations of dinitrophenol do not affect carbon dioxide formation during glucose fermentation. (4) Thiol reagents like ethyl iodoacetate ($4 \cdot 2 \times 10^{-4}$ *M*) or chloroacetophenone ($6 \cdot 0 \times 10^{-4}$ *M*), which do not inhibit carboxylase, strongly inhibit pyruvate decarboxylation by the living yeast cells. (5) Pyruvate oxidation is associated with orthophosphate uptake, which is inhibited by dinitrophenol (Table 3) in about the same degree as pyruvate consumption.

Table 3. Effect of 2,4-Dinitrophenol on Orthophosphate Exchange Associated with Pyruvate Oxidation

43·0 mgm. (dry wt.) yeast suspended in 12·0 ml. 0·05 *M* phthalate with 205 μM pyruvate. *p*H 4·5. Oxidation for 40 min., at 30°. The figures represent μM pyruvate and orthophosphate (μP) consumed and allow for the respective controls. Initial orthophosphate, 3·50 μP.

Additions	Pyruvate	μP
Pyruvate	76·8	2·82
„ and $0 \cdot 8 \times 10^{-4}$ *M* 2,4-dinitrophenol	18·2	0·18

On the evidence already given, it may be concluded that (*a*) *S. cerevisiæ* oxidizes aerobically *added* pyruvate by means of an enzymic mechanism similar to pyruvate oxidase from animal tissues; (*b*) carboxylase does not belong to this system, although it does decarboxylate pyruvate formed inside the yeast cell; and (*c*) carboxylase seems to be in a metabolic region of the yeast cell not accessible to the pyruvate or inhibitors present in the suspension medium. The existence of these metabolic regions in the yeast cells has been recently reported by Conway *et al.*[11].

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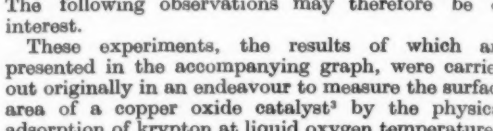
Influence of a Chemisorbed Film on Subsequent Physical Adsorption Processes on Solids

Despite the great amount of experimental work in the past twenty years on the physical adsorption of gases by solids, the effect of a chemisorbed film on the subsequent physical adsorption of other gases has never, to our knowledge, been thoroughly investigated. However, occasional observations have been noted, particularly in connexion with the Brunauer–Emmett–Teller surface-area measurements[1]; and the general conclusion has been that the presence of a chemisorbed film does not affect such measurements, provided that there is no blocking of capillaries, as might occur on a porous solid[2]. The following observations may therefore be of interest.

These experiments, the results of which are presented in the accompanying graph, were carried out originally in an endeavour to measure the surface area of a copper oxide catalyst[3] by the physical adsorption of krypton at liquid oxygen temperatures, using the standard adsorption technique. All measurements were made on the same 7-gm. sample of catalyst.



Curve I, clean surface of copper oxide; curve II, after adsorbing carbon monoxide to saturation at room temperature, giving a coverage of approximately 20 per cent, that is, 1·5 c.c. of carbon monoxide; curve III, after addition of approximately 4 c.c. of oxygen to surface II, converting the carbon monoxide to a CO_2-surface complex (ref. 3); excess of oxygen is present on the surface. Curve III is also the isotherm for the surface after 3·8 c.c. of oxygen, only, has been adsorbed at room temperature, corresponding to about 100 per cent coverage

These results are completely reproducible, the chemisorbed gases being removed by evacuation of the catalyst at 180° C. to give a clean surface on which the adsorptions can be repeated. The isotherms shown are the mean of two or three independent runs in each case.

The krypton adsorptions give good straight lines when plotted according to the Brunauer–Emmett–Teller equation, the average V_m values being I, 4·35 c.c.; II, 3·51 c.c.; III, 4·22 c.c., in agreement, so far as can be judged, with the 'point *B*' values[1]. Two isotherms were also obtained with butane at — 78° C., the V_m values being I, 2·30 c.c., II, 1·86 c.c.

The phenomenon is at present the subject of a more comprehensive investigation in this laboratory, and a full discussion will be published elsewhere. How-

ever, we feel that a qualitative interpretation of the influence of a chemisorbed film may be based on the following lines.

It is assumed that these isotherms represent the start of a multi-layer condensation process, that is, the '*S*-shaped' isotherms of the Brunauer–Emmett–Teller theory. Again, following the Brunauer–Emmett–Teller treatment, we assume an average heat of adsorption on the clean surface to be E_1 for the first layer and E_L for subsequent layers, where E_L is approximately, if not exactly, equal to the heat of liquefaction of the adsorbate. Let the average heat of physical adsorption on the chemisorbed film be E'_1 for the first layer, and E_L for subsequent layers. In general, $E'_1 \neq E_1$, but providing $E'_1 > E_L$, then, though the isotherms for the clean and contaminated surfaces will not exactly correspond, nevertheless the point B and V_m values will be approximately the same. We suggest that this is the case in curve III for chemisorbed oxygen and the CO_2-complex. Indeed, the isotherms here indicate that $E'_1 > E_1$ at low coverages, a fact which lends itself to interesting speculation.

On the other hand, if $E'_1 < E_L$, then effectively no condensation will occur, at low relative pressures, on that fraction of the surface which is covered with the chemisorbed film; and the isotherm and V_m value will correspond to the bare portion of the surface only. This, we suggest, occurs in curve II, where approximately 20 per cent of the surface is covered with chemisorbed carbon monoxide and the decrease in adsorption of krypton (and butane) is of that magnitude.

The question arises as to the likelihood of E'_1 being less than E_L in this case, that is, of the heat of adsorption of krypton on chemisorbed carbon monoxide being less than the heat of liquefaction of krypton. It is, of course, fairly easy to show that the van der Waals attraction between an isolated 'gas-phase' carbon monoxide molecule and a krypton molecule would be less than that between two krypton molecules. If we assume that on chemisorption the polarizability, 'characteristic energy' and dipole moment of the carbon monoxide molecule are not markedly increased, then it is quite probable that $E'_1 < E_L$. Conversely, if these isotherms are accepted as evidence that $E'_1 < E_L$, then it is possible to draw some qualitative inferences as to the nature of the chemisorbed state of carbon monoxide.

It is obvious that these very simple observations do not in any way depend on the more quantitative aspects of the Brunauer–Emmett–Teller theory which have recently been questioned[4]. Certain implications of the above treatment are being examined both theoretically and experimentally, and will be published in due course.

We are indebted to Prof. W. E. Garner for much helpful discussion on this subject.

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Association Reaction of Methyl Radicals

The nature of the bimolecular radical reaction which terminates the chains in the high-temperature photodecomposition of acetaldehyde will only be shown by analysis. Assuming the reaction:

$$CH_3 + CH_3 \rightarrow C_2H_6,$$

the amount of ethane to be expected can be calculated by the graphical integration

$$\frac{k_1 R_0}{2K^2 p_0\{1-\exp(-\alpha p_0)\}^{1/2}} \int_{p_0}^{p_1} \frac{\{1-\exp(-\alpha p)\}^{1/2}}{p}\, dp \approx \frac{k_1}{\varphi}\left(1 - \sqrt{\frac{p_1}{p_0}}\right)$$

where p_0 mm. acetaldehyde have been irradiated, decomposing at initial rate R_0, to a final acetaldehyde pressure p_1 mm. The light absorbed is given by $I = 1-\exp(-\alpha p)$; K is the overall reaction constant, where $R = KpI^{1/2}$; φ is the overall quantum yield, and k_1 is the quantum yield of the primary process,

$$CH_3CHO \xrightarrow{h\nu} CH_3 + CHO.$$

The amounts of ethane thus obtained are such that only mass spectrometry will detect and estimate them in the presence of considerable quantities of methane and carbon monoxide.

Analyses have been carried out on the products of prolonged photolysis (up to 24 hr. for at least 90 per cent decomposition) of 200 mm. acetaldehyde at various temperatures and with $I_0 \approx 10^{-10}$ $N\bar{h}\nu$. cm.$^{-3}$sec.$^{-1}$, $\lambda = 2537$–3130 A. Table 1 shows the results obtained (after removal of residual aldehyde).

Table 1

Temp. ° C.	Mole (per cent)				
	CO	CH_4	HCHO	H_2	C_2H_6
123 obs.	49·6 50·4	43·5 42·4	0·2 0·2	2·9 3·1	3·9 3·9
calc.	50·0	41·8	4·1		4·1
212 obs.	49·8	44·7	0·2	3·3	2·1
calc.	50·0	49·0	0·5		0·5
422 obs.	49·9	48·7	<0·1	0·9	0·5
calc.	50·0	50·0	<0·01		<0·01

Probable errors in analysis for formaldehyde, hydrogen and ethane are ± 0·2 mole per cent. The presence of formaldehyde is thus not definitely established.

Some preliminary analyses for ethane showed the same trend (see Table 2).

Table 2

Temp. ° C.	125	140	308
Ethane (obs.)	2·7	2·7	1·1
,, (calc.)	3·3	1·4	0·07

Some peaks of very low intensity at mass numbers 31, 40–46, 58, 60 indicated traces of other oxygenated compounds. In particular, upper limits of 0·2 and 0·05 per cent respectively can be given for glyoxal and diacetyl.

The presence of ethane is consistent with the assumed termination reaction; though the calculated figure is subject to some uncertainties, particularly in the value to be given to k_1, the quantum yield of the primary process. Here we use $k_1 = 0·5$. The

formaldehyde and hydrogen probably arise from side reactions,

$$CHO + CHO \rightarrow HCHO + CO$$
$$\searrow H_2 + 2CO,$$

the material balance requiring that $p_{C_2H_6} = p_{HCHO} + p_{H_2}$.

If the ethane does arise from the reaction between methyls, this excludes the reaction

$$CH_3 + CHO \rightarrow CH_4 + CO$$

as the chain termination. On the other hand, it does not exclude the alternative mechanism in which formyl radicals propagate the chain, when the reaction between methyl radicals would be the side reaction. Nevertheless, the weight of evidence is for methyl radicals as chain carriers. If that is the case, the above analysis suggests that the termination is, in fact,

$$CH_3 + CH_3 \rightarrow C_2H_6.$$

This view is further substantiated by the agreement between the constants determined, by the sector method, for the termination reaction in the photolyses of acetaldehyde[1] and of mercury dimethyl[2]. The observed frequency factors, of the same order as the collision frequency, do not, however, agree with the steric factor 5×10^{-3} found by Marcus and Steacie[3] for the same reaction.

We have recently learned that Danby, Buchanan and Henderson[4] have carried out, independently, extensive mass spectrometric analyses on the products of the reaction in its initial stages and have reached the same conclusion about the chain-ending process.

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Feb. 24.

[1] Dodd, R. E., *Trans. Faraday Soc.*, **47**, 56 (1951).
[2] Gomer, R., *J. Chem. Phys.*, **18**, 998 (1950).
[3] Marcus, R. A., and Steacie, E. W. R., *Z. Naturforsch.*, **4a**, 332 (1949).
[4] Danby, C. J., Buchanan, A. S., and Henderson, I. H. S., *J. Chem. Soc.* (in the press, rec. January 17, 1951).

Use of 95 per cent Ethyl Alcohol as a Solvent for Ultra-Violet Spectroscopy

In connexion with a problem on the determination of the ultra-violet absorption spectra of organic molecules dissolved in 95 per cent ethyl alcohol[1], it was necessary to determine the suitability of the alcohol as a solvent in the region of 2000 A. There is a report[2] that carefully purified 95 per cent ethyl alcohol[3] is suitable for the region of 2000 A., although no experimental results were given. Observations in this region have been reported by MacLean, Jencks and Acree[4] for ordinary commercial 95 per cent ethanol, and they find that unpurified alcohol is completely opaque in this region.

It seemed to be of interest, then, to determine the transmission of purified 95 per cent ethanol down to 2000 A. The results are shown in Table 1. The percentage transmission of the alcohol was determined with the aid of a Beckman quartz spectrophotometer equipped with a Nestor hydrogen lamp. The transmission of the alcohol at the various wavelengths was measured against distilled water, and it was assumed that the transmission of the water in this region was 100 per cent. Column *a* gives the results for the transmission of the untreated commercial alcohol; column *b* is for the alcohol after refluxing with dilute sulphuric acid and distillation[2], column *c* after treatment of the acid-treated alcohol with silver oxide and distillation. Repetition of the purification procedure with this alcohol did not materially change the values reported in column *c*.

Table 1

λ (A.)	(*a*) % Transmission	(*b*) % Transmission	(*c*) % Transmission
2300	62	68·2	83·8
2250	54	59·2	76·5
2200	46	50	67·5
2150	36	40	57·5
2100	28·2	33·8	45·5
2060	17	18·5	29·2
2040	10·8	10·9	18·9
2020	5	5	9
2000			6

Pirlot[5] has recently described another method for the purification of alcohols for ultra-violet spectroscopy, consisting in treatment with iodine, removal of the iodine with zinc and then passage of an alkaline solution of the alcohol over a column of activated charcoal. The results for ethyl alcohol in the region of 2000 A. were not reported; but from the data for the transmission of methyl alcohol in this region, it would seem that the values for ethyl alcohol treated in this fashion would be similar to those reported now.

Table 2

λ (A.)	(*a*) % Transmission	(*b*) % Transmission
2300	75·5	79·8
2250	68·0	70·8
2200	60	62·3
2150	50·8	54·0
2100	30·0	43·0
2050	9·0	18·2
2020		9·1
2000		3·5

An investigation of the transmission of commercial absolute alcohol was also made. The results are shown in Table 2. Column *a* shows the transmission for the untreated alcohol; column *b* shows the transmission after refluxing with dilute sulphuric acid, distillation and treatment of the distillate with silver oxide. The first and last 15 per cent of each distillate was discarded.

On the assumption that the solvent should transmit at least 50 per cent of the radiation[2] to be suitable at any particular wave-length, it would appear that even carefully purified 95 per cent ethanol is not a suitable solvent for work below 2100 A., and absolute alcohol is not suitable below 2120 A.

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Johns Hopkins University,
Baltimore 18, Maryland.
Nov. 30.

[1] Moser and Kohlenberg, *J. Chem. Soc.* (in the press).
[2] Harrison, Lord and Loofbourow, "Practical Spectroscopy", 418 (Prentice-Hall, New York, 1948).
[3] Leighton, Cary and Schipp, *J. Amer. Chem. Soc.*, **53**, 3017 (1931).
[4] MacLean, Jencks and Acree, *J. Res. Nat. Bureau of Standards*, **34**, 271 (1945).
[5] Pirlot, *Bull. Soc. Roy. Sci. Liège*, **18**, 115 (1949).

FORTHCOMING EVENTS

(Meetings marked with an asterisk • are open to the public)

Saturday, April 21

NORTH OF ENGLAND INSTITUTE OF MINING AND MECHANICAL ENGINEERS (at Neville Hall, Newcastle-upon-Tyne), at 2.30 p.m.—Mr. Haswell Alder, Mr. S. W. Potts and Mr. Arthur Walker: "Mechanized Room and Pillar Mining—a General Appreciation of Developments in this Country".

Monday, April 23

ROYAL GEOGRAPHICAL SOCIETY (at 1 Kensington Gore, London, S.W.7), at 5 p.m.—Prof. Carl Troll: "High Mountain Physiography and Plant Geography in Different Climatic Belts".

BRITISH SOCIETY FOR THE HISTORY OF SCIENCE, PHILOSOPHY OF SCIENCE GROUP (in the Joint Staff Common Room, University College, Gower Street, London, W.C.1), at 5.30 p.m.—Dr. N. W. Pirie, F.R.S.: "Concepts out of Context—The Pied Pipers of Science".

INSTITUTION OF ELECTRICAL ENGINEERS, RADIO SECTION (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Discussion on "The Trend of Design of Television Receivers" (to be opened by Dr. A. J. Biggs).

Tuesday, April 24

INSTITUTION OF CIVIL ENGINEERS (at Great George Street, London, S.W.1), at 5.30 p.m.—Mr. G. A. Maunsell: "Some Unsolved Problems in Civil Engineering" (James Forrest Lecture).

CHEMICAL SOCIETY, LEEDS SECTION (joint meeting with the UNIVERSITY CHEMICAL SOCIETY, in the Department of Chemistry, The University, Leeds), at 6.30 p.m.—Dr. J. Kenyon, F.R.S.: "The Use of Optically Active Compounds in the Study of Organic Reactions".

MANCHESTER GEOGRAPHICAL SOCIETY (at the Geographical Hall, 16 St. Mary's Parsonage, Manchester), at 6.30 p.m.—Mr. Reginald Booth: "Germany".

SOCIETY OF INSTRUMENT TECHNOLOGY (at Manson House, 26 Portland Place, London, W.1), at 6.30 p.m.—Sir Frederic Bartlett, F.R.S.: "Human Control Systems".

Wednesday, April 25

SOCIETY OF CHEMICAL INDUSTRY, FOOD GROUP (joint meeting with the ROYAL SANITARY INSTITUTE, in the Cambridge Hall, Municipal Buildings, Southport), at 10 a.m.—Discussion on "Composition and Scientific Control in the Manufacture of Ice-cream, Synthetic Cream and other Emulsified Food Products" (to be opened by Mr. A. L. Bacharach).

INSTITUTE OF FUEL (at the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, W.C.2), at 10 a.m. and 2.30 p.m.—"A Study of Drying" (Final Conference).•

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 2.30 p.m.—Sir Andrew Bryan: "Safety in Mines" (Cadman Memorial Lecture).

GEOLOGICAL SOCIETY OF LONDON (at Burlington House, Piccadilly, London, W.1), at 3 p.m.—Annual General Meeting; Prof. O. T. Jones, F.R.S.: "The Drainage Systems of Wales and the Adjacent Regions" (Anniversary Address).

ROYAL INSTITUTE OF CHEMISTRY, NEWCASTLE-UPON-TYNE AND NORTH-EAST COAST SECTION (in the Chemistry Building, King's College, Newcastle-upon-Tyne), at 3 p.m.—Symposium on "Infra-Red Spectroscopy".

ASLIB (in the Lamont Room, National Book League, 7 Albemarle Street, London, W.1), at 4 p.m.—Annual General Meeting.

ROYAL STATISTICAL SOCIETY (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 5.15 p.m.—Mr. D. J. Morgan and Mr. W. J. Corlett: "The Influence of Price in International Trade, a Study in Method".

UNIVERSITY OF LONDON (in the Anatomy Theatre, University College, Gower Street, London, W.C.1), at 5.30 p.m.—Inaugural Lecture by Prof. F. Brailsford: "Magnetic Materials in Electrical Engineering, their Limitations and Improvement".•

UNIVERSITY OF LONDON (at King's College, Strand, London, W.C.2), at 5.30 p.m.—M. André Chevallier: "The Use of Carrier Currents for Control, Protection and Communication in Power Systems".• (Further Lectures on April 27, 30 and May 2.)

BRITISH INSTITUTION OF RADIO ENGINEERS, WEST MIDLANDS SECTION (at the Wolverhampton and Staffordshire Technical College, Wulfruna Street, Wolverhampton), at 7 p.m.—Dr. T. Emmerson: "Some Physical Principles used in Electronic Equipment".

Thursday, April 26

ROYAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 2.30 p.m.—Discussion on "Symbiosis involving Micro-organisms" (to be opened by Dr. H. G. Thornton, F.R.S.).

UNIVERSITY OF LONDON (in the Physiology Theatre, University College, Gower Street, London, W.C.1), at 4.45 p.m.—Prof. H. A. Krebs, F.R.S.: "Energy Transformations in Living Matter".• (Further Lectures on May 3, 10 and 17.)

INSTITUTION OF ELECTRICAL ENGINEERS (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Sir John Cockcroft, F.R.S.: "Modern Conceptions of the Ultimate Structure of Matter" (Forty-second Kelvin Lecture).

PHYSICAL SOCIETY, ACOUSTICS GROUP (in the Lecture Theatre, Science Museum, Exhibition Road, London, S.W.7), at 5.30 p.m.—Discussion on "The Calibration of Microphones by the Reciprocity Method" (to be opened by Mr. R. S. Dadson).

ROYAL AERONAUTICAL SOCIETY (at the Institution of Civil Engineers, Great George Street, London, S.W.1), at 6 p.m.—Discussion on "Air Travel from the Passenger's Point of View".

BRITISH INSTITUTION OF RADIO ENGINEERS, LONDON SECTION (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 6.30 p.m.—Mr. R. G. Kitchenn: "An 8-Channel Transmitter for an Experimental Carrier Wire-Broadcasting System".

CHEMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 7.30 p.m.—Prof. R. B. Woodward (Harvard): "Some Recent Advances in the Chemistry of Natural Products".

Thursday, April 26—Sunday, April 29

SOUTH-EASTERN UNION OF SCIENTIFIC SOCIETIES (at the Central Hall, The Avenue, Camberley).—Fifty-sixth Annual Congress.

Friday, April 27

MINERALOGICAL SOCIETY, CLAY MINERALS GROUP (at Rothamsted Experimental Station, Harpenden, Herts), at 2.15 p.m.—Discussion on "Relationship of Cation-Exchange Capacity to Clay Mineral Structure" (to be opened by Prof. H. Deuel (Zürich) and M. J. Méring (Paris)).

ROYAL ASTRONOMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Discussion of Papers received during the Session.

CHEMICAL SOCIETY, ST. ANDREWS AND DUNDEE SECTION (joint meeting with the UNIVERSITY CHEMICAL SOCIETY, in the Chemistry Department, United College, St. Andrews), at 5.15 p.m.—Prof. F. A. Paneth, F.R.S.: "Whence come Meteorites?—Views Ancient and Modern".

INSTITUTE OF ECONOMIC ENGINEERING (at Cowdray Hall, London, W.1), at 7 p.m.—Mr. H. A. Macdonald: "Problems of Organization".

ROYAL PHOTOGRAPHIC SOCIETY, KINEMATOGRAPH SECTION (at 16, Prince's Gate, London, S.W.7), at 7 p.m.—Review of New Apparatus for Narrow Gauge Films.

TELEVISION SOCIETY (at the C.E.A., 164 Shaftesbury Avenue, London, W.C.2), at 7 p.m.—Mr. J. E. Rhys-Jones: "Time Bases".

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 9 p.m.—Mr. H. M. Powell: "Atoms Engaged—a New Type of Compound".

Saturday, April 28

MINERALOGICAL SOCIETY, CLAY MINERALS GROUP (at Rothamsted Experimental Station, Harpenden, Herts), at 10 a.m.—Scientific Session, General Papers.

INSTITUTION OF CHEMICAL ENGINEERS, NORTH-WESTERN BRANCH (at the Reynolds Hall, College of Technology, Manchester), at 3 p.m.—Mr. H. E. Charlton: "Chemical Engineering as applied to the Building of a Petroleum Chemicals Plant".

SYSTEMATICS ASSOCIATION (at the City Museum, Leeds).—Symposium on "Evolutionary Trends and Classification".•

Sunday, April 29

INTERNATIONAL HAEMOPHILIA SOCIETY (at the Society for Visiting Scientists, 5 Old Burlington Street, London, W.1), at 2.30 p.m.—General Meeting.

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

LECTURER IN ORGANIC CHEMISTRY (to teach mainly organic chemistry up to A.R.I.C. and special degree standard), and a LECTURER IN PHYSICS (to teach physics to the standard of general B.Sc. degree, and applied mathematics and mechanics to Inter.B.Sc. students)—The Principal, Gloucester Technical College, Brunswick Road, Gloucester (April 28).

SCIENTIFIC OFFICERS, EXPERIMENTAL OFFICERS, SITE ENGINEERS, and TECHNICAL ASSISTANTS, by the Ministry of Fuel and Power for experiments in underground gasification (sites near Sheffield and in the West Midlands)—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting F.306/51A (April 28).

STATISTICIAN (with experience of medical data)—The Secretary, Institute of Psychiatry, Maudsley Hospital, Denmark Hill, London, S.E.5 (April 28).

ASSISTANT LECTURER IN VETERINARY SCIENCE at Makerere College (University College of East Africa)—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W.C.1 (April 30).

ASSISTANTSHIP IN PATHOLOGICAL BIOCHEMISTRY at Western Infirmary—The Secretary of University Court, The University, Glasgow (April 30).

LECTURER IN BOTANY at the University of Malaya—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W.C.1 (April 30).

LECTURER IN CIVIL ENGINEERING—The Registrar, King's College, Newcastle-upon-Tyne (April 30).

PROFESSORS OR LECTURERS IN GEOGRAPHY, PHILOSOPHY, MATHEMATICS, CHEMISTRY, PHYSICS, BOTANY, ZOOLOGY, ENGLISH, ECONOMICS, POLITICAL SCIENCE, at the University College of Arts and Science, Baghdad—The Director, Personnel Department, The British Council, 65 Davies Street, London, W.1 (April 30).

SENIOR LECTURER OR ASSISTANT LECTURERS (2) IN PHYSIOLOGY—The Secretary of University Court, The University, Glasgow (April 30).

ASSISTANT LECTURERS or LECTURERS IN AGRICULTURE, BOTANY, CIVIL ENGINEERING, and MATHEMATICS, at Gordon Memorial College, Khartoum, Sudan—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W.C.1 (May 1).

CHAIR OF AGRICULTURE at Gordon Memorial College, Khartoum, Sudan—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W.C.1 (May 1).

LECTURERS or SENIOR LECTURERS IN MECHANICAL ENGINEERING, VETERINARY ANATOMY, and PHYSIOLOGY, at the Gordon Memorial College, Khartoum, Sudar—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W.C.1 (May 1).

RECOGNIZED TEACHER IN BACTERIOLOGY AND ASSISTANT BACTERIOLOGIST, and a DEMONSTRATOR IN BACTERIOLOGY AND ASSISTANT BACTERIOLOGIST—The Registrar, The University, Bristol (May 1).

HYDROGRAPHIC SURVEYOR with the Geelong Trust Commissioners, Geelong, Victoria—A. E. Turner and John Coates and Co., Ltd., Victoria House, Melbourne Place, London, W.C.2, quoting Ref. 604 (May 2).

ASSISTANT LECTURER IN PHYSICS, and a LECTURER or ASSISTANT LECTURER IN THEORETICAL PHYSICS—The Registrar, King's College, Strand, London, W.C.2 (May 5).

BIOCHEMIST (honours graduate, versed in problems of partition chromatography) to organize work in this field on vitamins, enzyme systems and amino-acids in their relation to ruminant digestion and secretion of nutrients into milk—The Secretary, National Institute for Research in Dairying, Shinfield, Reading (May 5).

BROWNE RESEARCH FELLOW IN ZOOLOGY or BOTANY—The Provost, Queen's College, Oxford (May 5).

LECTURER or SENIOR LECTURER IN THE DEPARTMENT OF ANATOMY—The Registrar, The University, Liverpool (May 5).

LECTURER IN ELECTRICAL ENGINEERING at University College, Dundee—The Secretary, The University, St. Andrews (May 7).

LECTURER IN ORGANIC CHEMISTRY at the University of Hong Kong—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (May 7).

CHEMISTS (with a university degree, with first- or second-class honours in chemistry) on the scientific staff of the Chief Engineer's Department in the Research Laboratories at Leatherhead—The Secretary's Office (Establishments), Application Section, British Electricity Authority, British Electricity House, Great Portland Street, London, W.1, quoting AE/148 (May 8).

ASSISTANT CURATOR at the Royal Botanic Gardens, Kew—The Secretary, Civil Service Commission, 6 Burlington Gardens, London, W.1, quoting No. 193/51 (May 10).

LECTURER IN PHYSICS—The Clerk to the Governors, Woolwich Polytechnic, Woolwich, London, S.E.18 (May 10).

RESEARCH FELLOWSHIPS (2), and a HUNTER AND PALMER'S AGRICULTURAL RESEARCH FELLOWSHIP, for independent research—The Registrar, The University, Reading (May 14).

LECTURER IN NATURAL PHILOSOPHY at University College, Dundee—The Secretary, The University, St. Andrews (May 15).

SENIOR LECTURER IN GEOLOGY, with special qualifications in petrology, geophysics or economic geology, at the University of Sydney—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (May 15).

DEMONSTRATOR IN ANATOMY—The Registrar, The University, Sheffield (May 19).

SENIOR LECTURER IN INORGANIC CHEMISTRY at the University of Queensland—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (May 19).

SENIOR LECTURER or LECTURER IN PHYSIOLOGY at the University of Sydney—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (May 19).

HEAD OF THE PATHOLOGY AND BACTERIOLOGY DEPARTMENT—The Secretary, Rowett Research Institute, Bucksburn, Aberdeenshire (May 31).

ELLISON FELLOWSHIPS (3) for postgraduate research in chemistry or physics—The Registrar, The University, Sheffield (June 1).

HEADMASTER—The Secretary, King Edward's School, Edgbaston Park Road, Birmingham 15 (June 16).

BACTERIOLOGIST (Grade I) to take charge, under the direction of the Professor, of the Public Health and Venereal Diseases Laboratory Service for the Bristol area—The Registrar, The University, Bristol (July 1).

LECTURER (Grade II) IN BACTERIOLOGY (Veterinary)—The Registrar, The University, Bristol (August 1).

ASSISTANT LECTURER AND DEMONSTRATOR IN THE BIOLOGY DEPARTMENT—The Secretary, King's College of Household and Social Science, Campden Hill Road, London, W.8.

BIOLOGIST in the Department of Clinical Endocrinology (to be responsible for biological hormone assays in co-ordination with the chemist carrying out chemical assays)—The House Governor, Birmingham and Midland Hospital for Women, Showell Green Lane, Birmingham 11.

BRITISH RUBBER PRODUCERS' RESEARCH FELLOWSHIP, tenable in the Department of Mechanical Engineering—The Registrar, The University, Nottingham.

DEPARTMENTAL RESEARCH ASSISTANT, to devote his time to the operation and maintenance of an air-driven ultracentrifuge—Dr. P. Johnson, Department of Colloid Science, Cambridge.

DEVELOPMENT GROUP MANAGER in the Division of Atomic Energy (Production), Ministry of Supply Factory, Capenhurst, near Chester (to supervise and participate in research work at a large chemical plant)—The Ministry of Supply, Division of Atomic Energy (Production), Risley, Warrington, Lancs, quoting Ref. CC/4.

EDITORIAL ASSISTANT (with a degree or chemical qualification) for *The Analyst*—Dr. J. H. Hamence, Peek House, 20 Eastcheap, London, E.C.3.

LECTURER (preferably interested in vertebrate zoology), and LECTURERS (2, preferably interested in comparative physiology or entomology) IN THE DEPARTMENT OF ZOOLOGY—The Clerk, Birkbeck College, Breams Buildings, London, E.C.4.

LECTURER IN HORTICULTURE, and ASSISTANT LECTURERS IN GEOLOGY, MATHEMATICS (pure or applied), GEOGRAPHY (with special qualifications in regional geography and map work)—The Registrar, The University, Nottingham.

MATHEMATICIANS to study theoretical problems connected with the design and performance of nuclear reactors and atomic energy plants—The Ministry of Supply, Division of Atomic Energy (Production), Risley, Warrington, Lancs.

RESEARCH ASSISTANT, for work on equilibrium diagrams of high melting alloys—Dr. W. Hume-Rothery, F.R.S., Inorganic Chemistry Laboratory, South Parks Road, Oxford.

RESEARCH ASSISTANT (university graduate in chemistry with experience in biochemistry) IN THE DEPARTMENT OF CLINICAL PATHOLOGY—The Secretary, University College Hospital Medical School, University Street, London, W.C.1.

SURVEYORS, to take charge of Provincial Cadastral Survey offices, Nigeria—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting 27076/13.

UNIVERSITY GRADUATES and QUALIFIED TEACHERS for Commissions in the Instructor Branch, Royal Navy, mainly for officers with qualifications in mathematics, science (physics, chemistry or metallurgy), or engineering—The Director (P), Education Department, Admiralty, London, S.W.1.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Institute of Social Medicine. Fifth Annual Report, 1949. Pp. 16. A Report on the Work of the Institute of Social Medicine, 1943–50. Pp. 16. (Oxford: Institute of Social Medicine, 1950.) [151

Review of Recent Work on Nitrogen Metabolism, by H. S. McKee; Experimental Methods available for the Study of the Nitrogen Metabolism of Plants, a Review of some Recent Advances, by H. E. Street. (*New Phytologist* Reprint No. 21.) Pp. 96. (London: Cambridge University Press, 1950.) 7*s.* 6*d.* [151

Overseas Food Corporation. The Future of the Overseas Food Corporation. (Cmd. 8125.) Pp. 20. (London: H.M. Stationery Office, 1951.) 9*d.* net. [161

Scientific Proceedings of the Royal Dublin Society. Vol. 25 (N.S.), No. 12: Atmospheric Pollution in Dublin during the Years 1944 to 1950. By A. G. G. Leonard, D. Crowley and J. Belton. Pp. 166–168. 6*d.* Vol. 25 (N.S.), No. 13: The Carboniferous Limestone in Co. Dublin south of the River Liffey. By J. Selwyn Turner. Pp. 169–192+2 plates. 6*s.* (Dublin: Royal Dublin Society, 1950.) [161

King's College: Dove Marine Laboratory. Report for the Year ending July 31st, 1948. Pp. 30. (Newcastle-upon-Tyne: King's College, 1950.) 5*s.* [161

Department of Scientific and Industrial Research: Road Research Laboratory. Road Note No. 5: Types of Road Surfacing and Maintenance using Tar or Asphaltic Bitumen. By Dr. A. R. Lee. Second edition. Pp. iv+24. (London: H.M. Stationery Office, 1950.) 1*s.* 6*d.* net. [161

Ministry of Agriculture and Fisheries. Bulletin No. 97: Pests of Flowers and Shrubs. By G. Fox Wilson. Second edition. Pp. iv+105+117 plates. (London: H.M. Stationery Office, 1950.) 4*s.* 6*d.* net. [161

Colonial Office. Appointments in His Majesty's Colonial Service. Pp. 125. (London: H.M. Stationery Office, 1950.) 2*s.* net. [161

Other Countries

University of California Publications in Zoology. Vol. 50, No. 1: Geographic Variation and the Species Problem in the Shore-Bird Genus *Limnodromus*. By Frank A. Pitelka. Pp. iii+108 (10 plates). (Berkeley and Los Angeles: University of California Press; London: Cambridge University Press, 1950.) 2 dollars. [151

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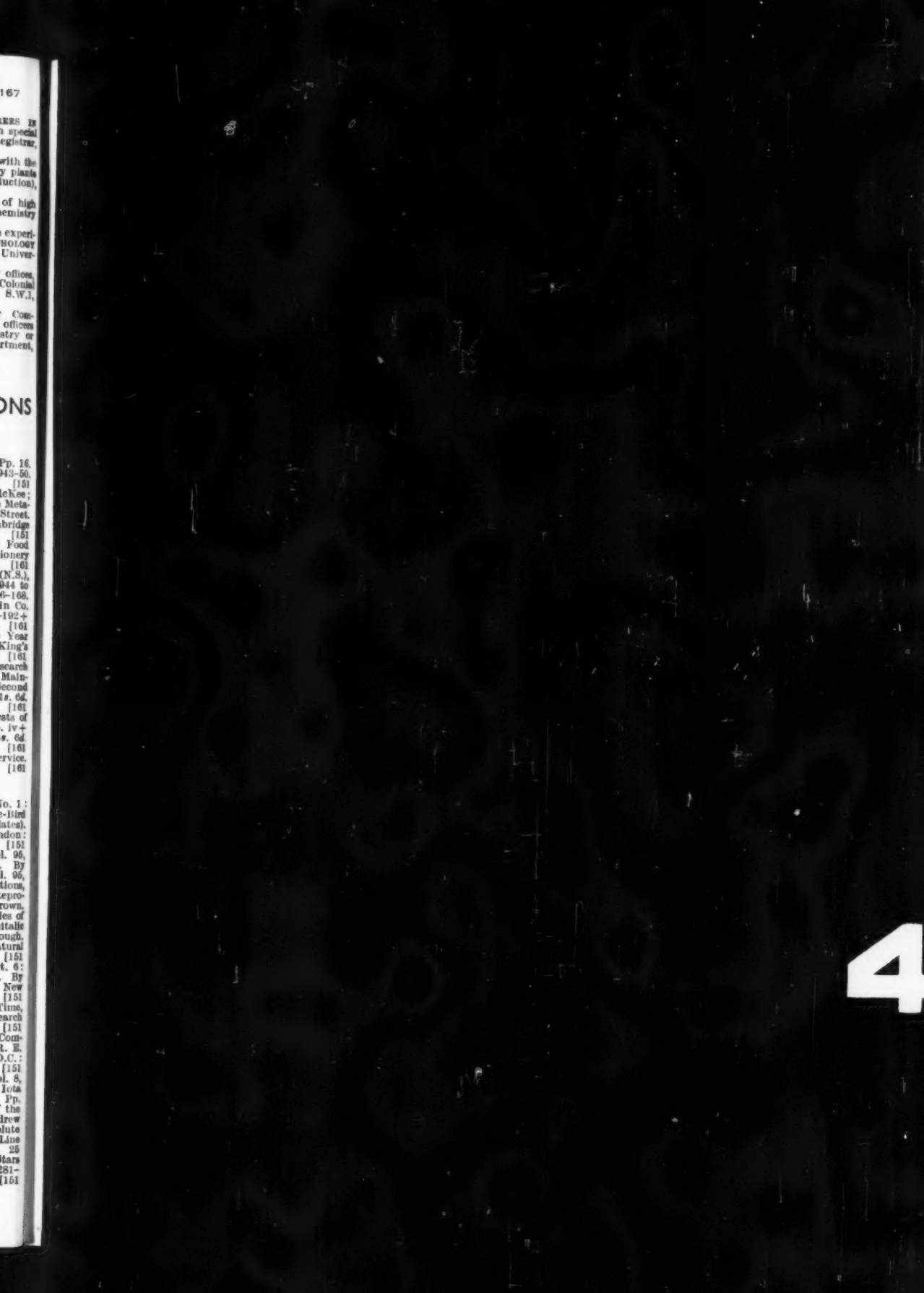
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